American Machinist

A McGraw-Hill Publication. . . Established 1877

New York, August 8, 1929

*

Design of the Zeiss Planetarium

A Complex Engineering Problem

By Henry Simon

Extraordinarily complex problems in the design of drives and mechanical movements are encountered in the Planetarium. This part of the article gives a general description of the problem and of the machine

THE ZEISS Planetarium is an elaborate and highly ingenious one-hundred-thousand-dollar ton of mechanism for showing the movements of the stars and planets on the inside of a large hemispherical dome. Though the ultimate purpose of the machine is of an optical nature, it is essentially the work of a mechanical engineer and designer.

Mechanical models, in general, for visualizing the movements of the heavenly bodies date back some hundreds of years. They have become to be known as "Orreries" because a particularly elaborate instrument of the kind was ordered built in England by Charles Boyle, fourth Earl of Orrery, (1676-1731). Orreries invariably were based upon the general plan of representing the chief heavenly bodies by spheres of various sizes, these spheres being supported on a movable framework and driven along their respective paths by more or less ingenious and effective mechanisms. The two-fold trouble with all of these models was that, although of unquestionable merit, the mechanical part was too much in evidence, while they failed to convey a realistic and inspiring conception of the happenings in the universe.

The Zeiss Planetarium, as shown in Fig. 1 and in diagram in Fig. 2, is based upon a radically different principle. In the diagram the major parts are indicated by the following numerals and letters: *1-1*—Polar axis, perpendicular to the earth's equator. *2-2*—Axis of ecliptic, perpendicular to the earth's orbit. *3-3*—Axis for varying the geographical latitude. A-A_1—Spherical carriers, containing 32 star projector-instruments. B—Cylindrical-frame section for the projectors for Mercury, the sun and the moon. B—Cylindrical-frame section for the projectors for Venus, Mars, Jupiter and Saturn. C-C_1—Gear-casing halves. D—Two motors for diurnal motion to review 24-hour day in either 4 or 1¼ min. E—Three motors for annual movement to review a year in 4 min., 1¼ min., or 7½ sec. H—Motor for rapid motion of precession, 26,000 years in 1½ minutes. J—Motor for rotating the instrument around axis *3-3* for varying geographical latitude. K-K_1—Spherical carriers, containing 32 constellation-name projectors. L-L_1—Spherical carriers, containing twelve instruments for projecting the zodiac and the celestial equator. M—Two spherical carriers, with four instruments for projecting the meridian. N—Individual star-field projectors. O-O_1—Nebulae projectors. P-P_1—Milky Way projectors. S—Central floor-switch. T—Locating bolt. V-V_1—Lamps for interior illumination of the dome. X—Common point of intersection of the three axes of the Planetarium instrument.

The first part of the article. The second part will appear in an early issue.

Instead of placing the observer in a position in outer space, the Planetarium follows the plan of putting him inside a miniature heavenly sphere, Fig. 3, and producing upon the inside of this sphere a realistic moving picture of the starry heavens by optical projection from the center.

The realization of this idea was due to the engineering genius of Prof. W. Bauersfeld, one of the heads of the Zeiss Optical Works at Jena, Germany. Years of design and experiment were required before the scheme completely satisfied the aims of its creator. In its final form, every single star visible to the unaided eye on a clear night is accurately shown within so close a distance of its actual relative position that astronomical observation by means of instruments would be required to reveal the error. The sun, the moon, and the planets visible to the naked eye, are seen to move through this array of nearly 9,000 stars along paths so nearly correct that the maximum positional deviation in the orbit of any one of the five planets would be only 1 deg. for a period corresponding to 5,000 years. Even the slow precessional motion of the earth's axis, Fig. 4, whereby the pole star is gradually being bereft of its present function, to travel on a mighty swing around the heavens once every 26,000 years, is taken exact account of, and proceeds whenever any motion of the artificial universe is going on.

Combined with true-to-nature effects, even down to the gradual coming of dawn or night, the illusion is so true that the onlooker at times almost forgets that he is not under nature's real sky. The chief value of the artificial heavens, however, lies in the speed with which the various changes may be made to take place, and in the ready command over a variety of events which in nature are quite beyond human control. The diurnal movement, by which the heavens seem to revolve once around the earth in 24 hours, is made to take place in 4 min., or in 1¼ min. And as for an ideal study of the planetary motions, even this acceleration is not sufficient. The whole year may be run off in 4 min., in 1¼ min., or in 7½ sec. At these speeds, the diurnal motion is stopped, the effect being as if the earth were moving around its orbit without rotating upon its axis.

Events may be speeded up once more, to show the heavenly vault as it was seen rotating around a different pole star, for instance, at the time of the building of the pyramids, or as it will be seen ten or twenty thousand years hence. This is done by the quick precession drive, which carries the pole of the heavens once around its 26,000-year cycle in 1½ min. While this motion is proceeding,

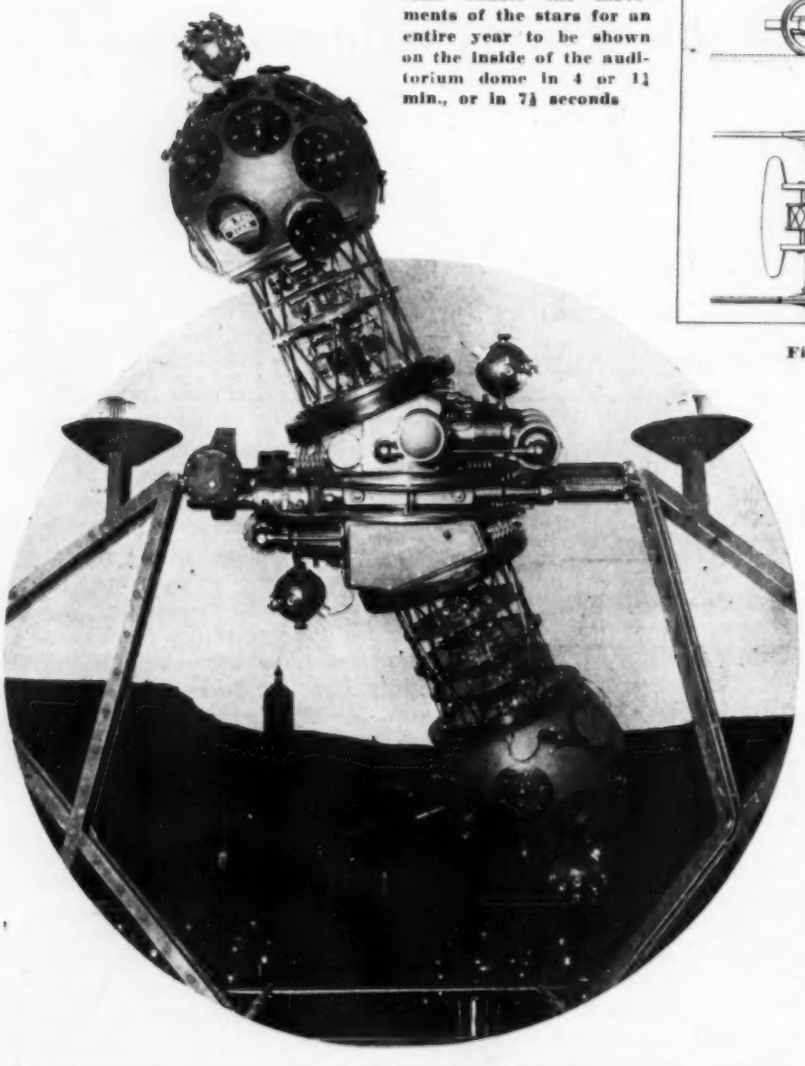


Fig. 1—The Planetarium instrument whose complicated and ingenious gear trains and mechanisms enable the movements of the stars for an entire year to be shown on the inside of the auditorium dome in 4 or 1¼ min., or in 7½ seconds

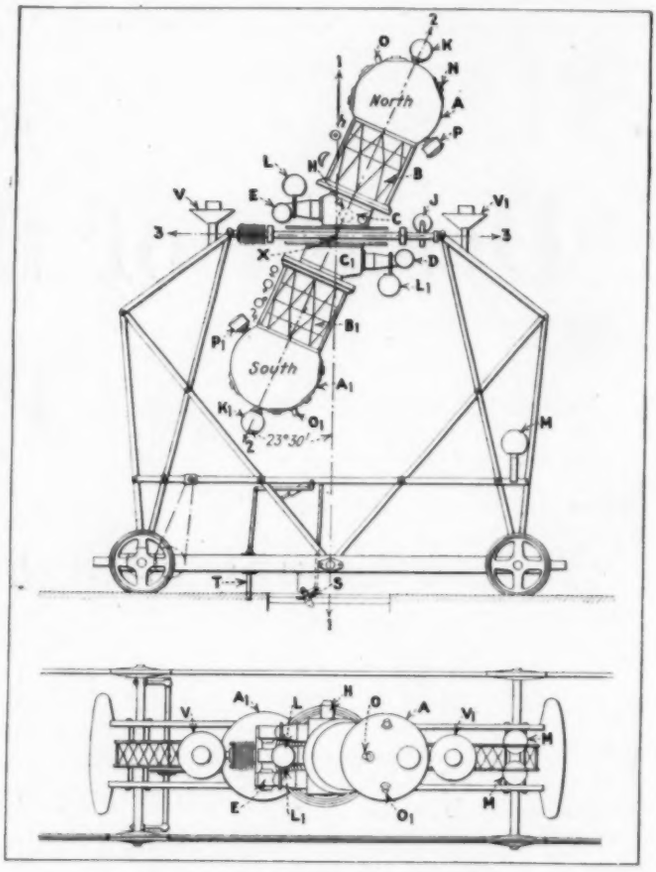


Fig. 2—Diagram of the latest design of the Planetarium instrument

both the diurnal and the orbitual motions of the earth are cut out, to be resumed again at will when the desired position of the pole star in time has been reached.

Another advantage of the Planetarium is that the aspect of the sky in any latitude can be produced in a few minutes. Constellations which the dweller in the northern hemisphere never sees, can thus be made to come into view and can be studied in detail. And over the entire expanse of the starry hemisphere, a numbered net of lighted reference lines may be instantly flashed for the exact orientation of the beholder. By noting the passage of the various bodies with reference to these lines of light, it is possible to read off the positions and estimate the movements of the various bodies in a very positive manner.

It must be clear that the design of an instrument able to satisfy these various unusual conditions must necessarily be complex. This will become even more plain when it is considered that besides such details as the phases of the moon, it is necessary to account for the degree of inclination of each planetary orbit to the ecliptic and the apparent loop motions of the planets, Fig. 5, while at the same time the period of revolution of each planet is incommensurable by that of every other. This latter combination of circumstances alone introduced an exceptional problem in gearing, although the main drive of the instrument is even more remarkable in this respect, involving as it does not only an extraordinary composite gear train, but also reduction ratios of totally unprecedented magnitude. Add to this an array of such minor but indispensable requirements as automatically shutting off the light from each and every projector, just above the heads of the audience, an extensive system of electric sliding contacts, and on top of all, the pressure of optical considerations which a mechanic would never suspect, and it will be seen that here was, indeed, an imposing engineering problem.

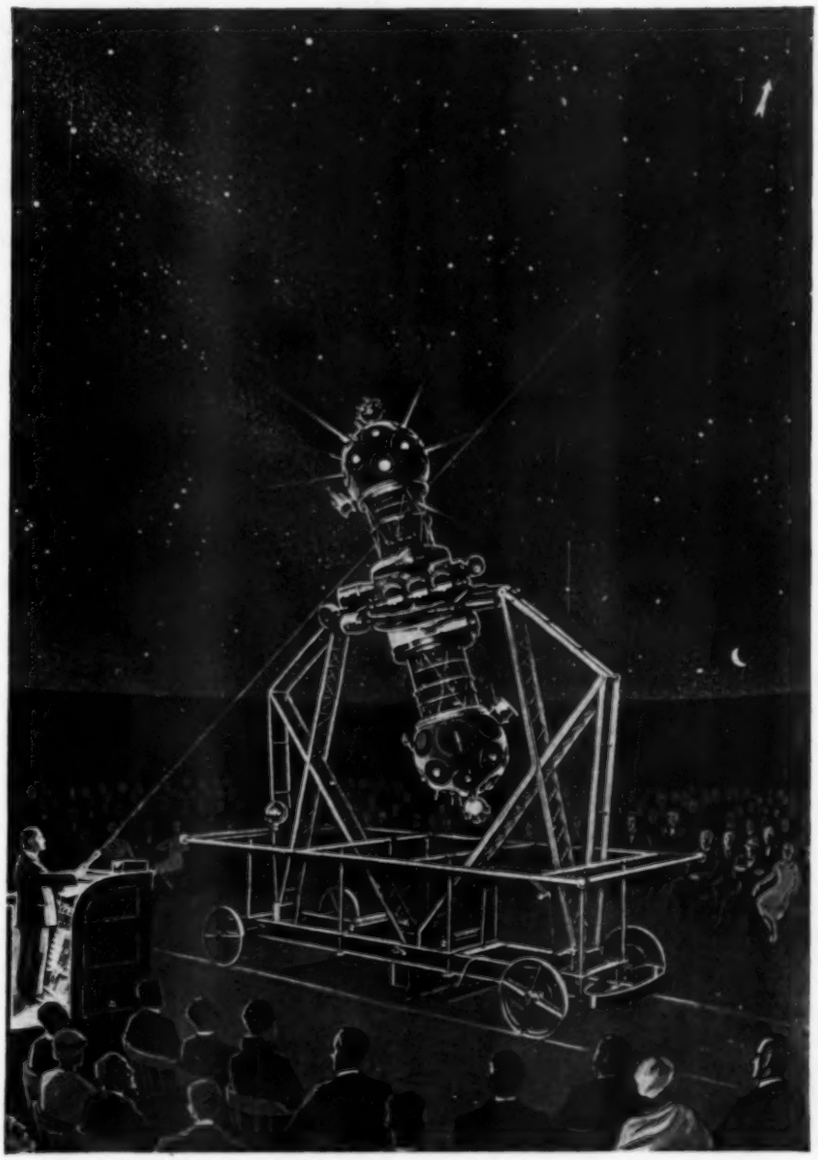


Fig. 3—How the Planetarium is used. Actually the machine and the audience are all but invisible during the lecture. The size of the stars is exaggerated

The broad idea underlying the instrument is that of a hollow, semi-spherical projector body, bearing upon its surface the fixed-star pattern and illuminated by a powerful central lamp, and an adjoining co-axial cylindrical framework divided into a number of chambers for individual moving projectors to represent the sun, moon, and planets. By endowing such a body with proper motions, a correct moving picture of the heavens could be produced upon the interior surface of a large hemispherical dome.

This general plan was followed in the first instrument at Munich, Germany, shown in Fig. 6 and in diagram in Fig. 7. Its main shortcoming was that it did not give a view of more than that section of the sky seen by an observer in one latitude—in this case that of Munich. It would, therefore, have been necessary to modify duplicates of this instrument for each and every different geographical latitude, while the fascinating possibility of watching the heavens as they look when viewed from the opposite hemisphere was altogether lost to the visitor.

To remedy this, as well as generally to improve the construction, the instrument was redesigned as it appears in Figs. 1 and 2. It will be seen that two semi-spherical star-image carriers, one for the northern and the other for the southern hemisphere, are provided at opposite ends of the instrument. Adjoining each of these carriers is a section of the cylindrical framework for the bodies of the solar system. Each of these in turn is mounted upon the side of one-half of a central casing containing the enclosed gear drive and six motors, and carrying the electrical connections and contacts, as well as various accessories. In addition to rotating motions around axis *1-1* and *2-2*, the whole is revolvable by a seventh motor around a horizontal axis *3-3* in the

trussed superstructure of a wheeled carriage. These three axes have a common point of intersection at *X*, and this point on the instrument is made to coincide with the geometrical center of the dome of the Planetarium.

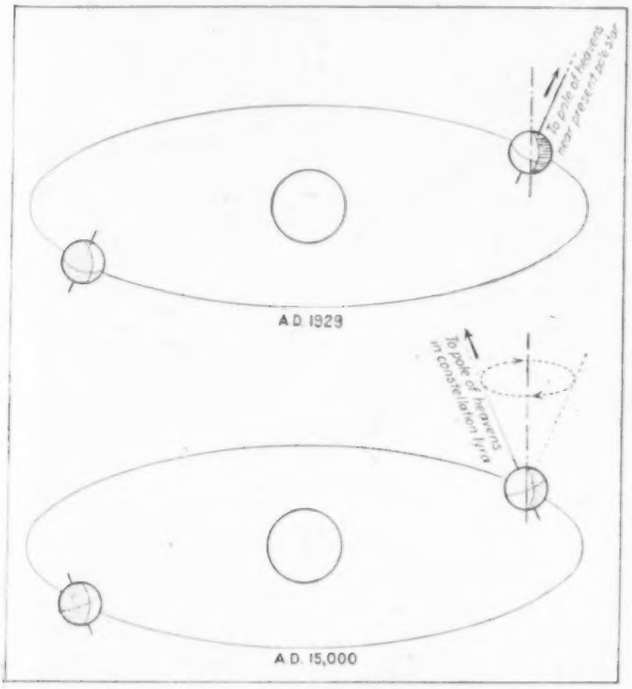


Fig. 4—The gyroscopic motion or precession of the earth's axis

A study of Fig. 9 will show why these three separate and distinct motions are necessary to account for the diurnal motion of the earth around its axis, for the precessional gyratory motion of the earth's axis causing the apparent movement of the pole star in 26,000 years, and to bring any one desired section of the heavenly vault before the eyes of the observers within the Planetarium.

The diagram, Fig. 8, represents the heavens as seen by a terrestrial observer in nature, and shows the duplication of phenomena in the Planetarium. In all cases, axes *1-1*, *2-2* and *3-3* are identical with those in Fig. 2. The shaded portions indicate the angle of the horizon, *L* being the horizon line. Since the vault of heaven in nature is at infinity, angle *M* is, in fact equal to zero. At *A* is what is seen of the heavenly vault by an observer in the latitude of Chicago. At *B* the Planetarium instrument is placed in a sphere to produce the same view. Note that by rotating the instrument around axis *1-1*, stars *A* and *B* travel along the same path as at *A*, while the pole star *P* remains stationary. *C* indicates how an observer in the latitude of Chicago will see the heavens in A.D. 15,000. The axis of the earth, and with it the pole of the heavens, has become inclined toward entirely different constellations. The present pole star describes a large circle every 24 hours, while star *B* is no longer visible to the northern observer.

A duplication of *C* in the Planetarium is seen at *D*. The order is apparently reversed, but an observer in the center, and having *L* as a horizon, will see identically the same phenomena as the observer in *C*. *E* represents a change in the view of the heavens by changing the station of the observer in *A* to just below the equator. The pole star is no longer visible. *H* is a view analogous to that of *E*, produced in the Planetarium by changing the relative positions of the instrument and the horizon line. At *J* a basic idea of the Planetarium is given. Each star is represented by a small hole in a spherical central body. By darkening any one half of the sphere representing the heavens, and revolving the spherical projector around axis *1-1*, the phenomena in *A* and *C* would be duplicated. Revolving it around axis *2-2* causes the motion of precession, or change of the pole of the heavens, as indicated by the horizontal lines. The Planetarium as it is, with the horizon line horizontal and fixed, is indicated at *K*. The instrument is adjusted to the latitude of Chicago, corresponding to *E*. Also the adjustment to the geographical latitude of *E* is indicated. Both will be found to correspond to *B* and *H*, respectively.

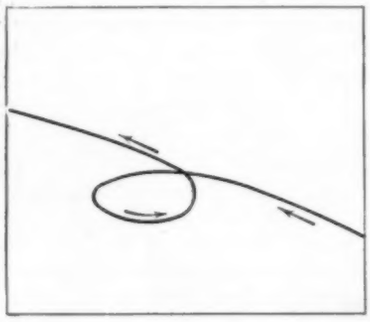


Fig. 5 — Apparent loop motion of a planet. To the view of the terrestrial observer, each planet seems to describe a number of such loops in each cycle it describes

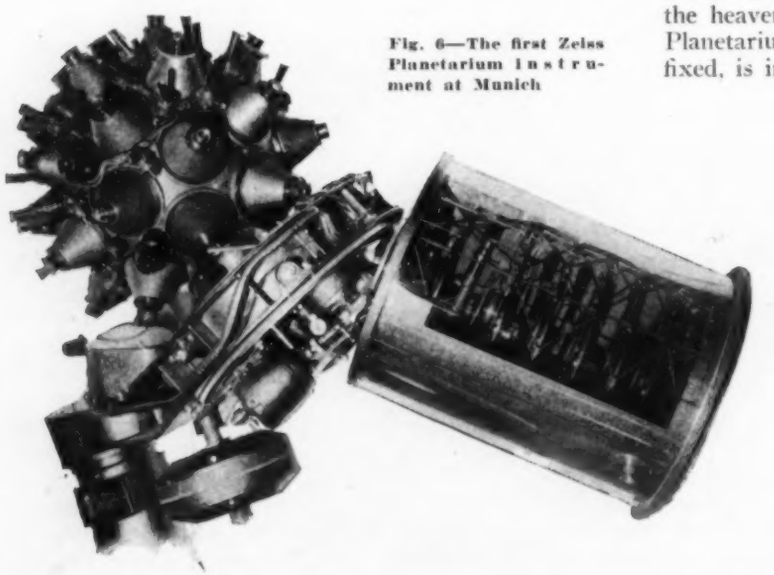


Fig. 6—The first Zeiss Planetarium instrument at Munich

Contrary to what might be a natural thought, axis *2-2* through the ball-shaped star-image carriers is not that around which the diurnal movement takes place. Instead, the extremely slow motion of precession only is served by it, and the diurnal movement, or daily rotation of the earth, is around axis *1-1*. Though axis *2-2* therefore describes during each diurnal rotation a gyratory movement identical with the slow precessional motion of the earth's axis, the pole star remains virtually stationary by reason of

its projection upon a point on the surface of the dome traversed by the continuation of axis *1-1*, as the diagrams *A* and *H* will show.

As the processional movement is taking place whenever the instrument is running, it will be plain that the pole star does very gradually change its position as the instrument slowly revolves around the long axis *2-2*. The resultant path of the present pole star upon the heavens is shown at *B*, and at *J* the corresponding phenomenon in the Planetarium.

The question might be asked as to how, with the fixed-star image carriers off center and in gyratory motion, it is possible to obtain an undistorted picture of the heavens. The answer to this apparent puzzle is quite simple in principle, and in so far as the second part is concerned, also in practice. Since all three axes of rotation intersect at the geometrical center of the hemispherical dome at *X*, the effect is the same as if the dome itself revolved around the point of intersection while the instrument stood still. The second part of the problem is also quite simple in theory, requiring as it does merely the proper offsetting of the positions of the star images in the carrier. In practice, its solution involved a great deal of calculation and called for the exercise of considerable thought.

This problem is still further complicated by the concentration of stars upon plates of individual star-image projectors. There is necessary, therefore, a double corrective displacement; first, that due to the concentration just mentioned, and second, the correction required to counteract the out-of-center location of the star-image carriers necessary in the new design of instrument. Naturally this latter correction must differ for individual projectors according to their positions upon the carrier. Regarding the method used, it suffices to say that both corrections

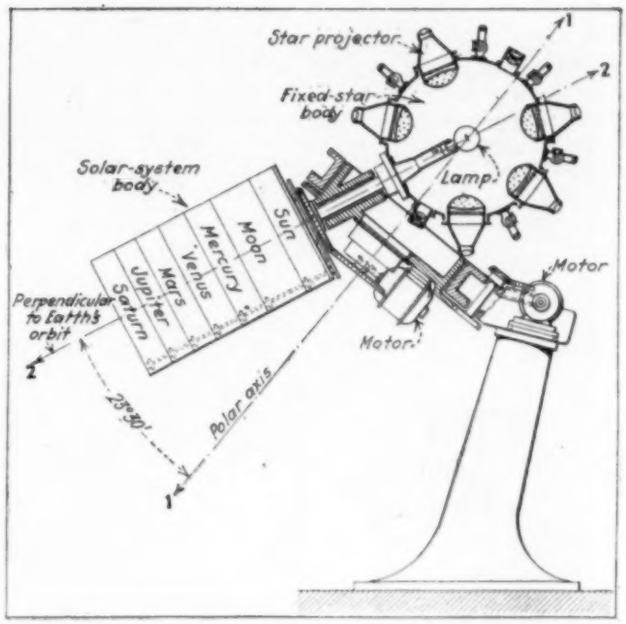


Fig. 7—Section through the Munich instrument. The center of the ball-shaped star carrier is in the center of the hemispherical dome

The plan for the projection of the fixed stars was developed on the hypothesis that instead of being spherical, the surface of projection was an icosahedron or twenty-sided body from which the twelve corners had been cut off. This produces a polyhedron bounded by twenty hexagons and twelve pentagons. Of these 32 fields, one half are served by sixteen projectors upon

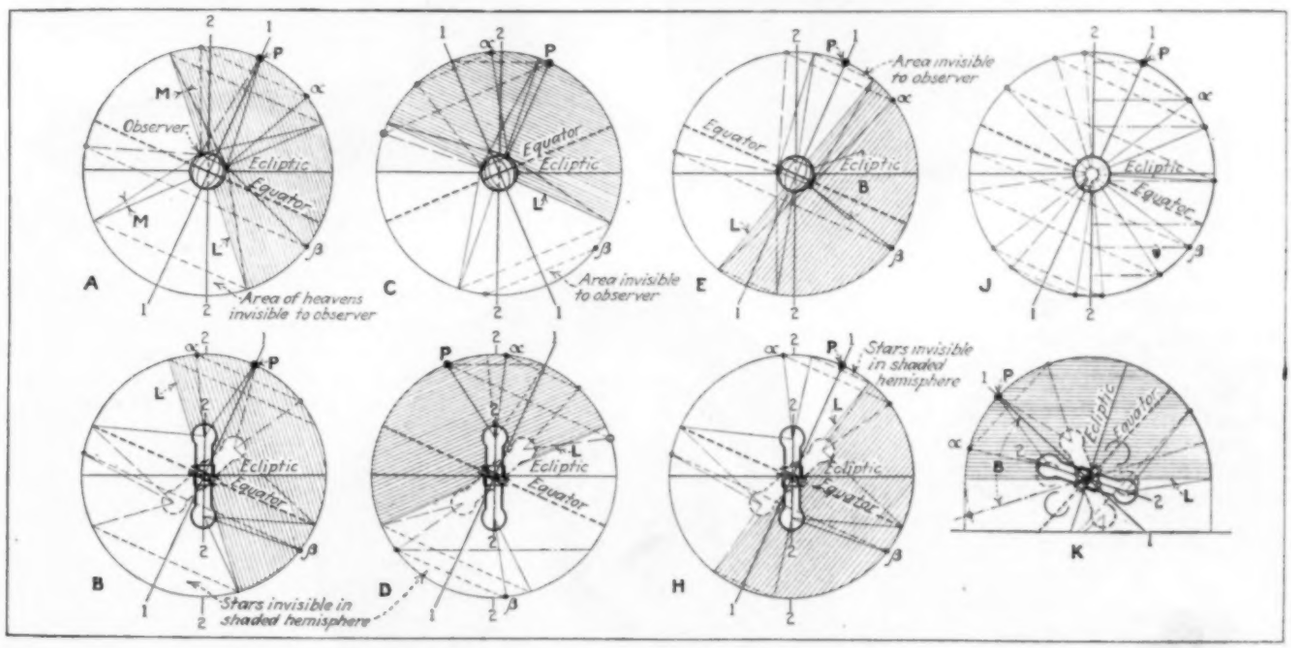


Fig. 8—Diagram representing starry heavens as seen by a terrestrial observer in nature

were made simultaneously by an optical process, in which each field of stars as it appears on the map was photographed under a double distortion, so planned as exactly to neutralize the errors otherwise arising in projection of the images of the fixed stars.

the carrier for the northern, and the other half by as many more projectors for the southern firmament. The sixteen projectors in each carrier are illuminated by a central lamp of 1,000 watts.

The construction of one of the individual star pro-

jectors is seen in Figs. 9, 10, and 11, in which like letters refer to like parts. Each projector is self-contained and is an entirely independent unit consisting of a funnel-shaped shell *A* bearing at its rear or inner end a collector lens *B*, and near its forward end an objective *C*. Just ahead of the collector lens is the image plate *D*, which in the first instrument was a glass negative. This has been replaced by a copper leaf 0.0006 in. thick, in which each individual star is represented by a small hole corresponding to the magnitude of the star. Altogether, the 32 image plates embrace a total of nearly 9,000 stars, which is slightly more than the average eye can see unaided. It is typical of the scientific conscientiousness of the maker that these holes are of 65 different sizes, representing that number of magnitudes as listed on standard astronomical maps.

An interesting mechanical detail is the gravity "stop" ahead of each objective. Stops of this kind are used in some form or other with each of the total of 101 projecting bodies on the instrument, to prevent any light from getting into the eyes of the audience. In the first instruments, recourse was had to a double-walled mercury vessel such as that in Fig. 12 at *A*. These liquid light stops worked well at the start, but trouble gradually manifested itself in the shape of an almost invisible film of oxide that was deposited on the glass walls under the action of the heat from the lamps. At *B* is one of the stops used on the small, ball-shaped projector carriers, in which the slightly irregular level-line produced by the adhesion of the mercury to the oxide film can be seen.

With but one exception, the stops in the new instrument are entirely mechanical. As seen, particularly in Fig. 9, they consist of a body *E* forming the outer race of a ball bearing, in which a ring *H* constituting the inner race is maintained in a given position by the pull of a weight *J*. Weight *J* is a hollow cylinder partly filled with mercury and is therefore highly sensitive to gravity in practically any position. Delicately pivoted upon a level axis, crosswise within this ring, is a spherical-sector cup K, the front edge of which is maintained level by means of a small weight *L* attached along the rear edge. As will be noted from the close-up of the instrument in Fig. 13 the effect of this arrangement is to keep the edge of the cup-stop at all times coinciding with the plane of the horizon line in the dome, and therefore just above the heads of the audience.

It hardly needs to be said that the adjustment of the 32 projectors upon their spherical carriers must be an important matter. This requirement is effectively met by a floatable mounting, in which the projector body, in

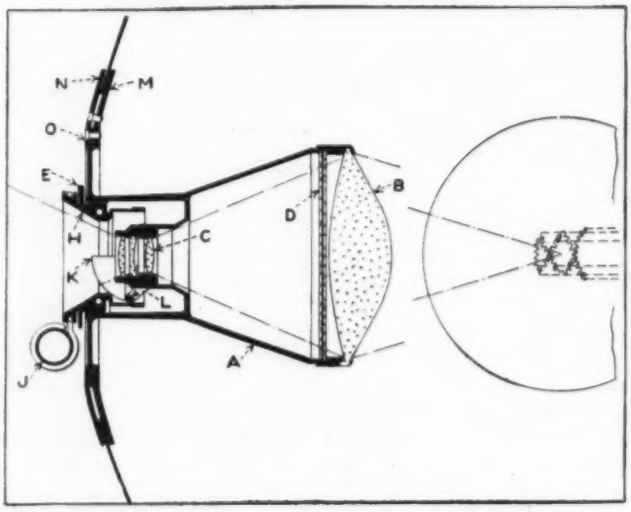


Fig. 9—Section through one of the fixed-star projectors. There are 32 such projectors distributed over the two large ball-shaped carriers. Each projector is a self-contained unit

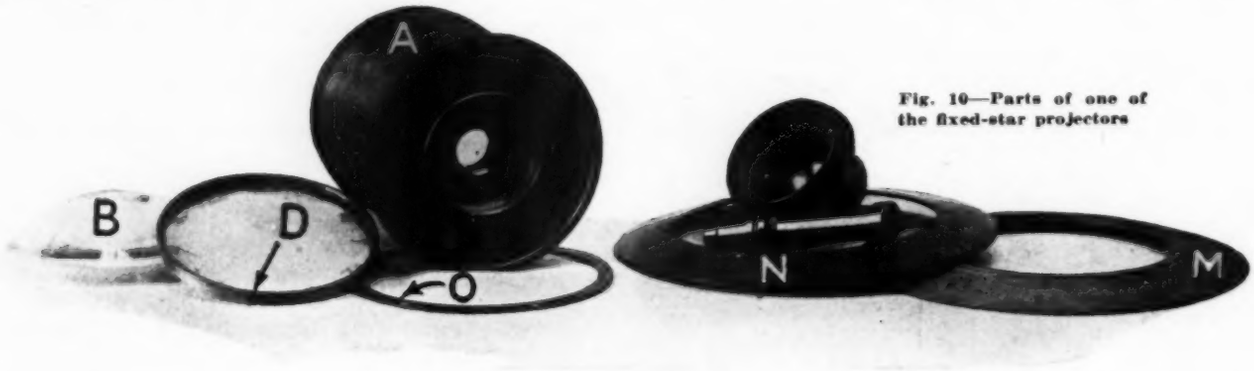


Fig. 10—Parts of one of the fixed-star projectors

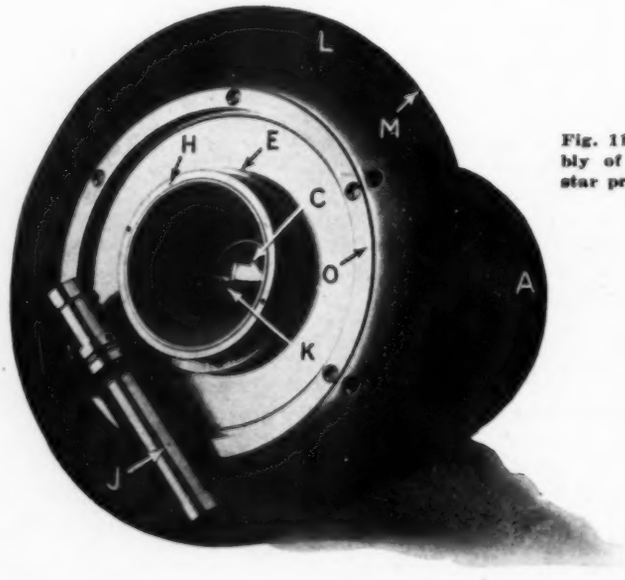


Fig. 11—Complete assembly of one of the fixed-star projectors

turn, may be independently rotated. The floatable mounting consists of the interior and exterior clamp rings *M* and *N*, seen in Figs. 10 and 11, turned on the radii of the carrier shell and held together by screws. The flange on the front of the projector body is a free turning fit in the seat formed by the rear clamp ring. The narrow lock-ring *O* is used for locking the flange to its seat.

This simple construction permits the rapid adjustment of the image in any sense with the help of temporary demarkation lines, and explains how a high degree of ultimate precision in the star pattern as it appears on the hemispherical screen is obtained at the need of no more than very ordinary accuracy in the ball-shaped carriers. It might be expected that the carriers would be light-metal castings machined on all surfaces. Instead, they are thin spheres made from 0.078-in. sheet brass, and practically the only machine work on them is the drilling and trepanning required to produce the various holes and openings.

The work on these and the smaller ball shells for the reference line and figure net-work projectors will be dealt with in a coming article devoted to some of the more unusual operations in fabricating parts of the Planetarium instrument. It may be mentioned, however, that one at first somewhat surprising fact about the instrument is the practically complete absence of light metal where light weight would seem a desirable quality. The materials used are brass, steel, cast iron and bronze all the way through. One reason for their use is the necessity for keeping the size of the parts down to the minimum in order to avoid as nearly as possible all obstruction to the rays from the numerous projectors. The main reason against the use of aluminum alloys in the present stage of their development, however, is the question of their stability in continued use over very long periods of time. Though the Zeiss Works is a large user of light metal, it was considered safer, in a costly instrument built to last and run for decades, to retain metals having a record of centuries of continuous service.

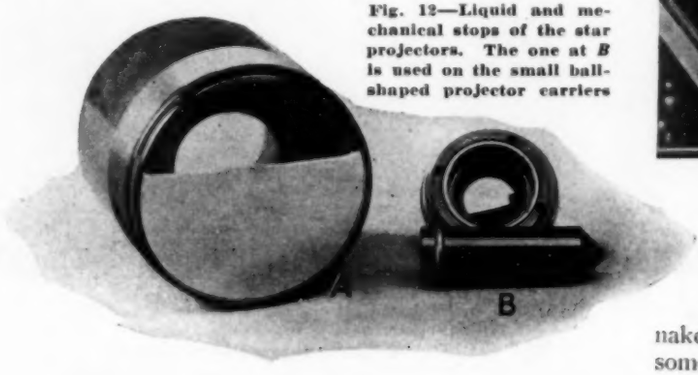


Fig. 12—Liquid and mechanical stops of the star projectors. The one at *B* is used on the small ball-shaped projector carriers

In addition to the 32 fixed-star projectors served by the central lamp in the carrier shell, are two small projectors for the prominent nebulae called the Magellanic clouds. One of these is seen at *A* in Fig. 13. Each one is a small tubular body containing an image of its nebula and having, in addition to the regular lens equipment, a small pivoted mirror that projects the image out at right angles from the side of the tube. By turning the tube and tipping the mirror, the image is easily brought to its correct position. The remaining nebulae visible to the naked eye are also provided for, but are incorporated in some of the star-image plates.

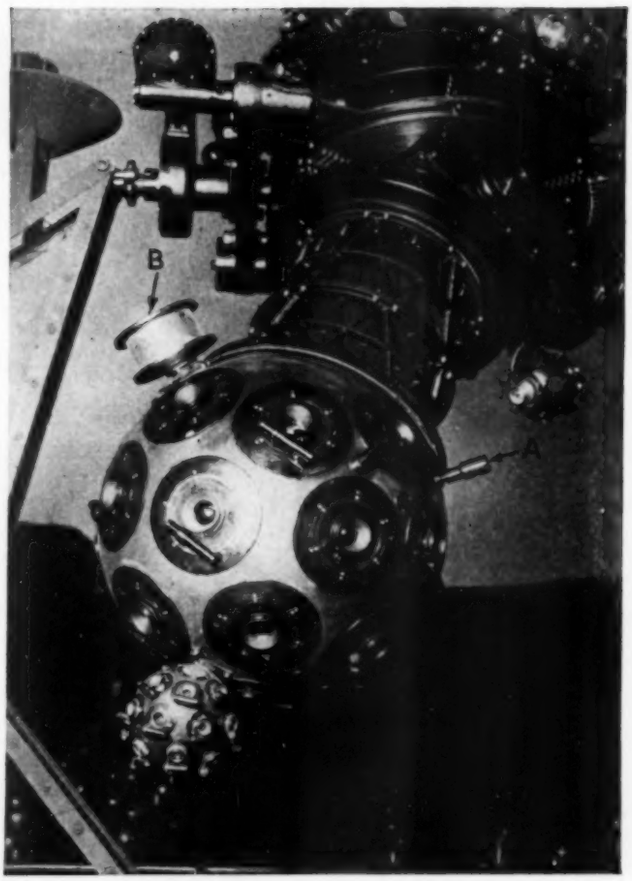


Fig. 13—Close-up of the North end of the Planetarium instrument. With the instrument in this position, the southern heavens are shown. At *A* is one of the projectors for the Magellanic clouds, while *B* is one of the projectors for the Milky Way

On the same general order, but very different in design, is the Milky-Way apparatus. It consists of two flat, drum-shaped bodies, one upon each star-image carrier shell, where it will be observed at *B* in Fig. 13. The cylindrical portion of each body is of glass and bears the image in the shape of a photographic film. A small 8-watt lamp in the center projects the image without the help of any optical equipment, merely by direct illumination. In Fig. 14 is shown one of the Milky-Way projectors with the cover removed, and a portion of the celluloid film visible. Due to the low power of the lamp, there is no appreciable heating, and hence the mercury type of the stop has been found satisfactory. It consists of an annular vessel forming the cylindrical portion of the projector and containing, in the narrow space between the walls, a quantity of mercury. A cellophane ring, spaced about an inch away from the vessel on the outside, serves for its protection.

Offhand, one might think that the projection of such a faint irregular blur as the Milky Way appears to be, would be one of the least worries of the designer. It is therefore surprising to note that the Milky Way caused more trouble than did the entire problem of fixed-star projection, by the difficulty of finding a satisfactory type of image. Though the casual observer may not be

conscious of it, the Milky Way is composed of areas of many different light intensities, and they had to be faithfully reproduced before it was possible to obtain the present true-to-nature picture.

In Fig. 15 is a reproduction of one-half of the Milky-Way film used in the projector. This image is made in accordance with a special map obtained from an astronomical observatory, and strikingly shows the difference in light intensity of different portions. A close study will show the fine network to be made up of a large number of irregular fields of equidistant white spots. These spots are arranged upon a curvilinear pattern in order to prevent refraction effects, such as would arise from a rectilinear pattern

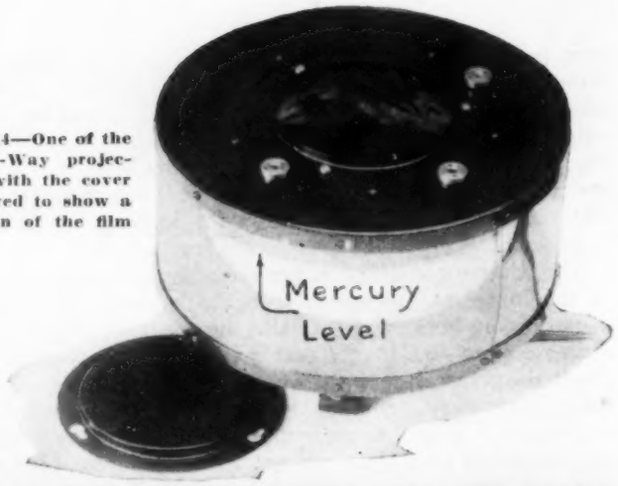


Fig. 14—One of the Milky-Way projectors with the cover removed to show a portion of the film

Fig. 15—One half of the Milky-Way film. The white dot at the upper right is "α Coronae Austrinae," one of the two points used to denote the positions of stars for locating the projected image with reference to the field of stars shown on the screen

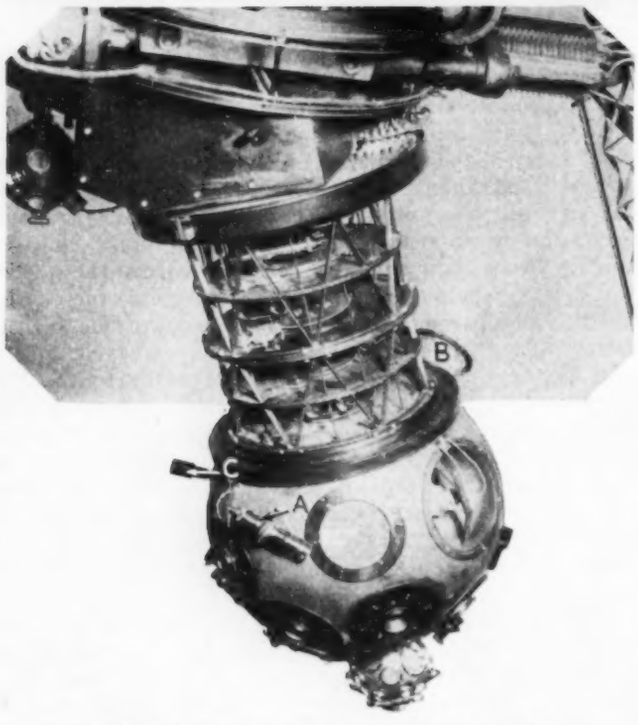


Fig. 16—The South end of the Planetarium instrument. The projectors for Sirius, the Milky Way and the nebulae are indicated by the letters

like that of the screen of a half-tone engraving. The two points marked "Canopus" and "α Coronae Austrinae" are the names of stars used as locating points for adjusting the position of the image with reference to the field of stars.

The manner in which the Milky-Way original was produced is characteristic of the care applied all the way through the instrument. A master pattern of dots arranged on concentric circles was first laid out on a large scale by draftsmen. This same pattern was then repeated ten times, each time with dots of larger size, giving ten patterns of as many graduated degrees of "darkness." Negative prints on a reduced scale were then made from each pattern, these prints showing white dots on a black background in ten different degrees of "lightness." By cutting out sections of the proper shape from a number of such prints and pasting them together on a board in an arrangement corresponding to the map, an accurate large-scale original was obtained. All that was then needed was photographic reduction to the proper size to yield the film.

It was found necessary to provide a separate projector for one single fixed star—Sirius, our nearest neighbor

among the fixed stars—which, because of its extreme brilliancy could not be satisfactorily reproduced by projection from the central lamp. Sirius, is, therefore, taken care of by a telescope-like projector fastened to the outside of the southern star image carrier, seen at *A* in Fig. 16. At *B* is the projector for the Milky Way, while that for the nebula is at *C*. In its construction, the projector for Sirius is essentially like the instruments used for some of the projectors in the solar system, which will next be considered.

The solar-system projectors are all based upon the same general idea of an illuminating body revolving around an axis roughly perpendicular to the ecliptic, or plane of the earth's orbit. It will be remembered from what has been said that this is the long axis *2-2*. The projectors comprise optical instruments, somewhat resembling binoculars in outward appearance, and are moved by double gear-trains that rotate them from a lineshaft actuated from the main drive. The two cylindrical cages in which these instruments are accommodated are each composed of two sections of nearly equal length, the sections being united by bolts. The "North" cage contains the projectors for the moon, the sun, and Saturn, while Mercury, Venus, Mars, and Jupiter are accommodated in the "South" cage.

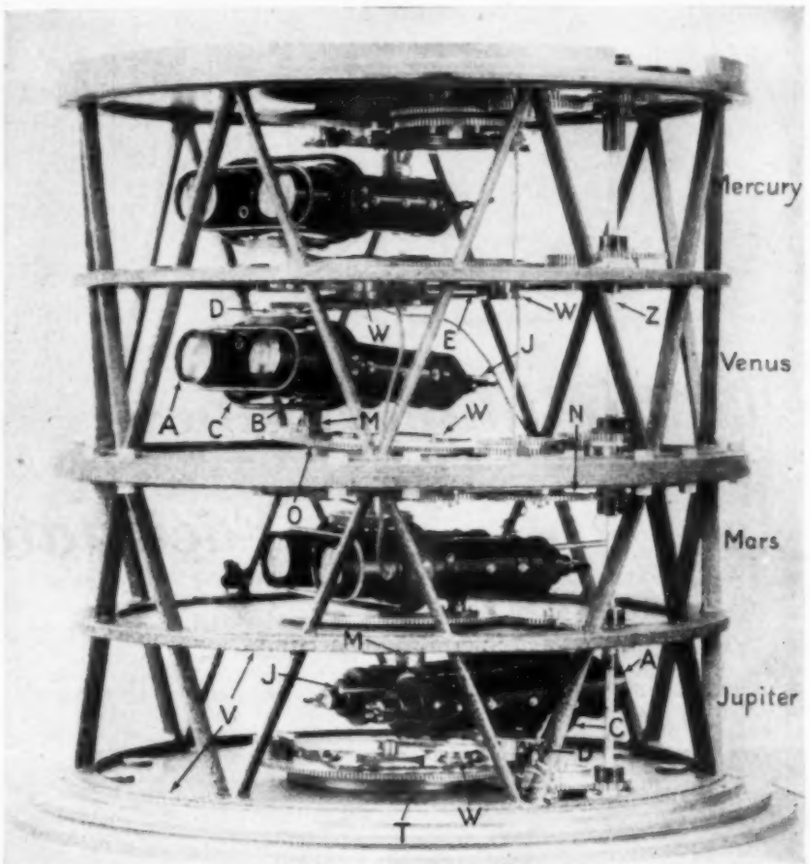
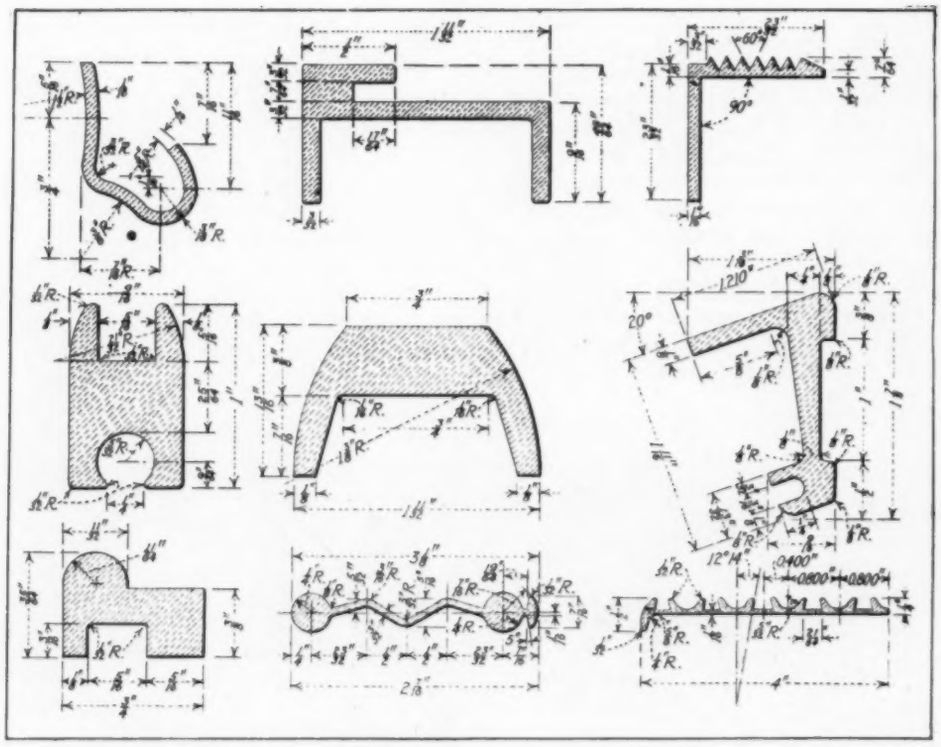


Fig. 17—Views of the planet cage with the instruments in two different positions. This cage contains the projectors for Mercury, Venus, Mars and Jupiter. Each optical instrument resembles a pair of binoculars. The projectors are rotated by double gear trains actuated by a lineshaft connected to the main drive

The doubling of the optical equipment of the projectors is necessary to prevent the light-ray from the instrument from being intermittently shut off by the trussing of the cylindrical cages and the frame members of the machine carriage. Except for the image they produce, the instruments for the five planets are all alike, and some idea of their construction can be gained from Fig. 17. In the sun and the moon projectors, the optical, as well as the mechanical arrangement differs from those for the planets. As shown in Fig. 17, the projectors *A* are mounted in spectacle-like holders *B*. Each holder rocks in its long axis in the frame *C*, which is revolvable about the bearing *D* on the terrestrial-drive disk *E*. Extending rearward from each holder is the aligning rod *J* by which the planet drive acts upon the instrument through a universal and sliding joint. The universal joint is mounted on the stud *M* and is centered over the slide *N* on the inclined planet-drive disk *O*. At *Z* is the lineshaft through which the power is transmitted to the gear trains.

Compensation in the mechanism for the variations in the speed of the sun's orbit, as it was worked out in the sun projector, will be taken up in the next part of this article. The projector comprises no less than four distinct sets of optical units, two sets producing the sun and its halo, the third set producing a faint luminous reflection of the sun upon the night sky, and the fourth set producing the image of the phenomenon known as the zodiacal light. One of the unusual elements of the design of the sun projector is the assumption, for purposes of design, that the sun travels around the earth once every 24 hours, instead of the actual case of the earth traveling about the sun. The alteration was necessary in the design of the Planetarium, but it can be demonstrated readily that no error can result from this hypothetical substitution. It was also necessary to reduce the light representing the sun to a very great extent in order to prevent it from interfering with the observation of the stars and planets, which in the Planetarium are visible at all times. Although the most complicated in its optical equipment, the solar projector is the simplest in its mechanical features. Because of the practically central position of the sun in the plane of the ecliptic, or earth's orbit, a simple train of spur gearing causing the instrument to revolve around the axis *2—2*, Fig. *2*, was sufficient to provide the desired effect in the mechanism of the Planetarium instrument.

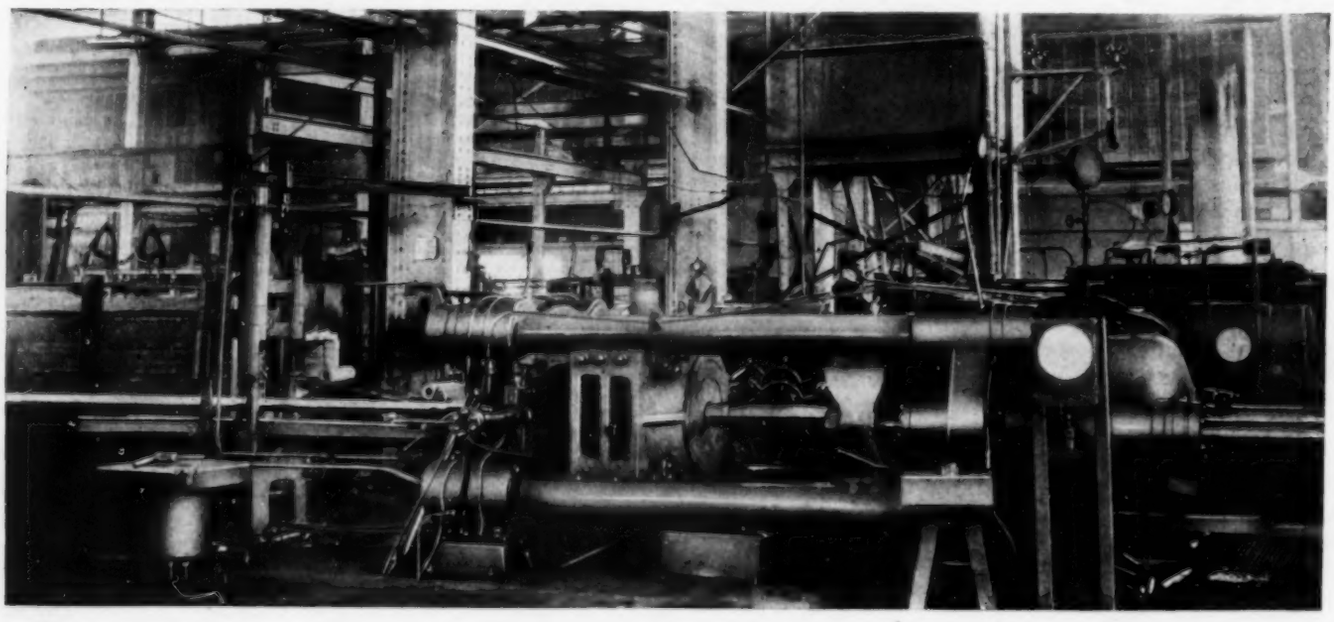
The next article also takes up the details of the planet mechanism and an unusual problem in gearing arising from the fact that the period of revolution of each planet-unit is an odd quantity in relation to every other unit, something which is contrary to practically all ordinary cases.



Typical examples of extruded aluminum bars. These designs have been developed for rods, struts, and moldings of airplane and other light construction, but they also show the ease with which irregular-shaped small parts of any machine or mechanism can be made by sawing off the bar to the desired length of part, thus eliminating expensive milling and other machine work in shaping the piece

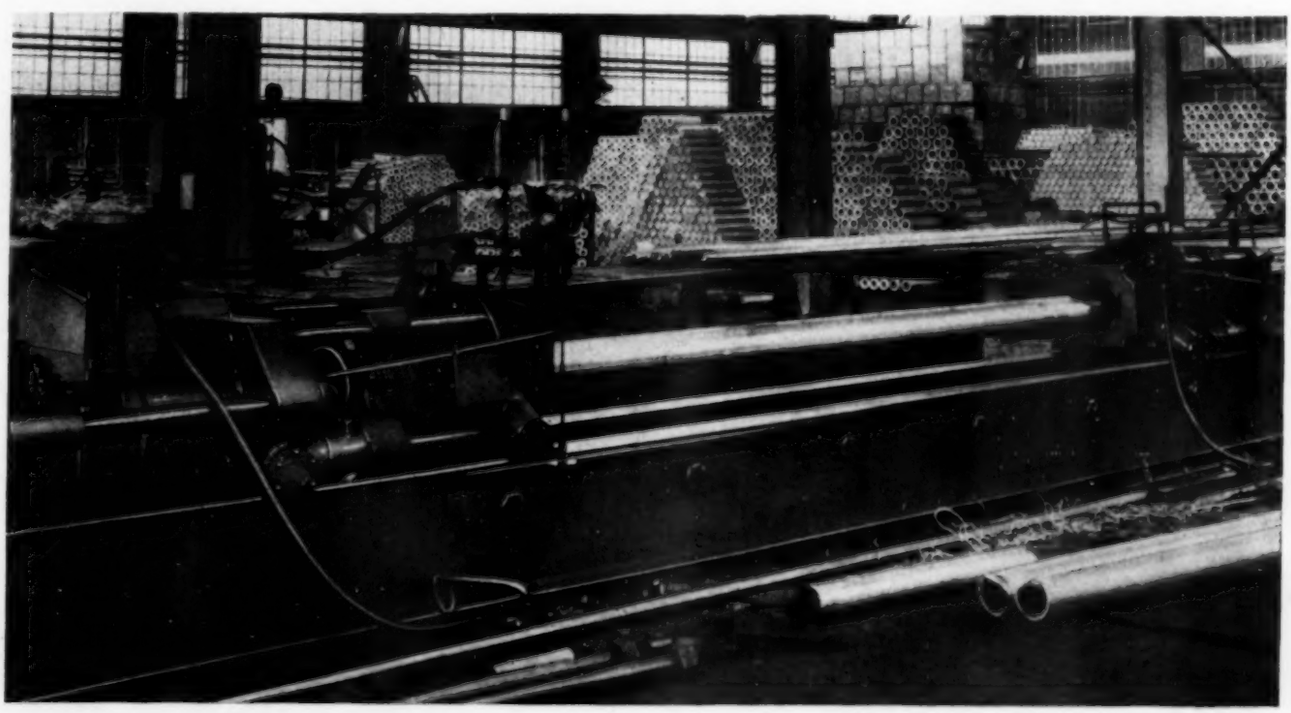
Extruded Aluminum Shapes Facilitate Design

THE possibility of obtaining almost any section in extruded light metals makes it easy for the designer to cut down the machining work in the shop to a minimum by careful attention in advance to the design of the section. While many standard sections are already available, an infinite variety of shapes may be obtained by changing dies. It is only necessary that the designer of the part take care that he proportions the fins and projecting edges so that there will be no weak points in the die. In the illustration below is shown the machine for extruding. A billet of metal is heated to about 950 deg. F. and forced through the die by means of a hydraulic ram operating at 1,000 to 2,000 tons pressure. Rods up to 40 ft. in length may be obtained by this process.



At the right is shown one of the heavy-type, extruding presses and the heating furnace. Below is shown a special machine for "stretching" the bars, which gives the effect of cold-working the metal

The extruded bar is shown coming from the machine on the ways *D*, in the illustration above. The furnace for heating the slugs of metal is at *B*, and the accumulators for the press are in the background. In the illustration below is shown the machine for "stretching" the bars after they have been extruded. In this operation, the bar or tube is held in the jaws of the carriages, which are then moved out hydraulically along the ways of the machine. The sizes of sections can be held to very close limits. Special aluminum alloys are used for bars which are to be heat-treated to obtain the desired physical and mechanical properties in the parts.



THE ENGINEERING C

The scene is a big production shop, which is consolidated also with an iron foundry and a nonferrous metal plant. It controls, also, a smaller shop that makes a specialty of contract production for the chain stores and mail-order houses. Conferences of the engineering and affected production executives with the chief engineer have grown into what the plant calls "The Engineering Council," which meets in a "council room" in the engineering department. Foremen are called in, and others drop

Design Changes that Influence Sales

"IT LOOKS all right to me," spoke up Ray Sellers, the sales manager, breaking into a long discussion of the merits of lightening the reciprocating mechanism of an automatic folding machine the company had been building on license. "I can feature in my advertising the smoother action of the machine, and it ought to give us another jump on our competitors. But the point I want to get across is that Art, here, ought to get his designers to produce something that won't mean tying up a bunch of money in stock parts for the machines already out and also causing a lot of annoyance to the salesmen because of the different sizes."

"Stockroom filled with odd parts because the designers didn't standardize on shaft spacings, bolt holes, etc."

"Right," chimed in George Overman, the superintendent, "it costs us *some* money out in the shop to make set-ups to fill all the little orders for miscellaneous parts, and the stockroom is always complaining about the cost of handling repair parts."

"Tell us just what you mean, Ray," said Arthur Levering, chief engineer.

"Well, Arthur, it's this. Why can't you designers standardize on the fitting dimensions on the parts changed, so that the new ones will go into the machines now in the field?"

"But these light alloys aren't as strong as the steel we've been using, and the whole form and shape will have to be changed," spoke up the chief draftsman, Andrew Lines.

"I'm no metallurgist," chimed in Paul Beyer, the P. A., "but from what I gather about the new light alloys we can get some that are pretty close to the strength of steel. Or, why don't you fellows try to work it out so you can use some of the new tough alloy steels that the airplane people are adopting? That would give you a chance to have light sections with the same strength."

"I'll tell you what we'll do," said the chief engineer, folding up his papers. "Andy will have his designer stick to all dimensions as they now are—shaft spacings, bolt holes, and width clearances—and design a set of parts in light alloy and one in, say, molybdenum steel."

"Better call off the dogs on those fancy alloys," butted in Jim Cutting, toolroom foreman. "We can't spend the money they do on airplanes, and those hard steels will likely bust up all the tools."

"That remains to be seen," concluded the chief. "We'll get estimates of the production costs as soon as we get the designs. And maybe what we save on extra-parts production and storage will allow you to spend more on machining. Anyway, we'll work for a design that will strike the field men in the eye, and that's what Ray is after."

Is the sales department overstepping itself when it expects the designers to meet its specifications, or should it be expected to sell what the designer produces? Are there any specific examples?

COUNCIL

in. The problems are not solved for the readers, but some of the opposing opinions are brought out. Engineers and designers are invited to discuss the problem, or to present new problems for discussion. Acceptable letters are paid for at regular rates.

DISCUSSION OF COUNCIL TOPICS

Design Changes That Influence Sales

THE controlling principle that the customer must be given what he wants is back of this problem. If one company will not do it, another will.

If the salesman, engineer, and designer work together, exchange ideas, and study their product from the customer's standpoint, the salesman will tell the customer what he wants before he knows it. If a company keeps the design of its product ahead, or abreast of, the demand, it will be able to make changes and improvements which must be made if the product is to live, in its own time and at a minimum cost for development as well as for parts for replacement. If the customer insists upon changes being made, the good salesman will turn these proposals in the direction of his company's capacity and policy.

The good designer will study the customer's requirements carefully, and will not accept the first easy solution that is proposed. He should not be constrained by the replacement-parts problem, but he should try to make the very best possible design. If he succeeds, the replacement-parts problem will decrease gradually in comparative importance.

—M. H. FLYNN, *Factory Manager, Allen Manufacturing Company.*

AS LATE as ten years ago, we in typewriter manufacturing, in common with most others in manufacturing and engineering, believed that the sales department should be expected to sell what the designer had produced and what mature engineering judgment had passed upon as being best-suited to the purpose.

The depression following the war brought out the acute need for something which would make a quick appeal to the buyer, in order to stimulate him to buy. This stimulation of sales by appeal to the buyer's artistic sense applies in all lines of manufacturing where beauty of design, in lines, and harmonizing colors can be applied.

It follows, therefore, that the sales department, which is in closer touch with the public than the manufacturing or engineering departments, is better suited to determine present-day requirements. Engineering and manufacturing have found it necessary to meet this present-day need by giving the sales department as nearly as possible what it wants, and the result has been greater patronage from the public and larger profits for the companies which are quick to meet public desires.

—B. J. DOWD, *Factory Superintendent, Royal Typewriter Company.*

THE modern sales idea is to give the customer the most for his money, and that which can be used to the best advantage in his business. A live salesman is not one who can gather the greatest number of signatures on the dotted line. The valuable salesman is the one who can get down to details, demonstrate the value of his product or machine to the customer, and at the same time be on the alert continually for any suggested improvements. Being in the field, the salesman obtains more readily the true attitude of the customers toward his own and competitor's products than does the designer with his limited outside contact. It is of advantage for the designer to absorb information obtained through the sales department when bringing out a new machine, and thus to give the customer something that will be in demand.

"By changes we progress," is an old saying, but the old method was mainly by means of manufacturing changes to reduce cost, such as the elimination of an operation, whereas now the method is: "Put the best of material and workmanship into the machine, speed it up, make longer bearings, and improve the oiling system, to hold the operating cost down." The difference will be made up through the purchasing market by increased sales.

—J. A. POTTER, *Chief Draftsman, Singer Manufacturing Company, Bridgeport.*

A QUESTION of whether the sales department is justified in expecting the designer to meet its specifications, or whether it should be expected to sell what the designer produces, is like the well-known law of supply and demand. The sales department certainly has some well-recognized rights in the matter, but it cannot expect to dictate constant improvements and refinements with no increased production costs. Nor is it always profitable to reduce production costs by increased volume at the dictation of the sales department, for selling costs may increase far more in proportion on the increased volume than the production costs are lowered. But as the word of a field representative who is on the spot at all times as far as customer contacts are concerned, the recommendations of the salesman should be given serious consideration. The maintaining of the proper balance between the representations of sales and design is really management's problem.

As an illustration of how standardization may be maintained throughout the ramifications of changing materials, an example may be cited from the aircraft industry. The original tension members in aircraft structures were of wire or cable, with turnbuckles and shackle ends for attachment to the structure. The gaps and pin-hole sizes in the forked ends of turnbuckles and shackles were originally determined by attaching them to mild carbon-steel terminal fittings on the structure. With the advent of alloy steels for fittings, the gaps and pin-hole sizes were maintained, but the widths of terminal lugs were narrowed accordingly, owing to the greater unit strength of the alloy steels. When streamline wires began to replace the cables and aircraft wires,

the forked terminals on the ends of the streamline wire were maintained with the same gap and hole sizes as those of the former turnbuckles and shackles. The introduction of Duralumin for structural fittings again found the gap and pin-hole size retained, but the terminal lug was widened accordingly. Here then, is a good example of constantly maintained interchangeability through various material changes, with no embarrassment to sales or service.

On the other hand, mere duplication of parts in a new material, even apart from strength considerations, often may defeat its own purpose. Each material has its limitations and advantages as far as production and design are concerned, and these must be carefully studied. For example, corrosion of Duralumin floats in seaplanes presents a serious problem. Monel metal, because of its extreme resistance to corrosion, was proposed as a substitute material. Mere substitution of Monel metal for Duralumin, considering its much greater weight and the practical limitations of thickness of sheet, would have produced a prohibitively overweight float. Yet, careful analysis, with proper modification of design, produced a float that weighed less than 10 per cent more than the corresponding Duralumin float.

So, I believe each case is an individual problem, to be attacked with caution, vigor, and a full realization that that which at first seems impossible can often be attained by close application. After all, the sales department is a vital factor in any organization, and the demands of the sales department should be considered with all seriousness.

—JOHN F. HARDECKER, *Chief Draftsman, Naval Aircraft Factory, Philadelphia.*

A VERY successful concern that I happened to know considerable about for several years had at that time three executives whose responsibility was about equally divided. One was a good business man, the second was a good designer, and the third was a good production man. While these men, as might be expected, disagreed frequently, they discussed matters freely until they arrived at a well-balanced conclusion.

A designer must design to sell, and a salesman must sell the design. Neither is a world unto himself, but each is very much dependent upon the other.

—MARTIN H. BALL, *Mechanical Engineer, Sweet & Doyle Foundry & Machine Company.*

THE question of design changes is more important than many seem to realize, as it concerns everyone from designer to customer. The decision to stick to all dimensions that affect interchange of new parts for old is wise and is followed by some well-known concerns. This is reported to be one of the strong claims that the Rolls-Royce automobile has on its owners.

Selecting new alloys is another good decision and while it sometimes brings out the objections of "busted tools" that Jim Cutting mentioned, modern knowledge of heat-treating frequently enables us to get the new, high-strength alloys into very "cuttable" condition. If this cannot be done, we have the new cutting-tool alloys to fall back on.

I know of shops where the stockroom ties up thousands of dollars that should be used in plant equipment and where the cartoon shown is but little exaggerated. It is these large stocks of spare parts, many of them practically obsolete, that makes it necessary to charge what seem to be exorbitant prices for repair parts. If parts interchange, it is often cheaper to sell a new design than one of the old ones. —CLIFFORD H. FRENCH.

THERE are two angles to the problem of design and its influence on sales. One is the effect on the customer that urges him to buy, and the other the cost to the shop that makes it necessary to ask what seems to be a high price. And in many cases, the salesman is responsible for unnecessary changes.

A salesman who knows but little of engineering probably requires new features to talk about. New designs appeal to him and he passes the enthusiasm on to his customers. The sales engineer, however, knows when a mechanism is good and can sell his customer on its engineering advantages until an improvement is found.

I am inclined to believe that more attention to the kind of salesmen and the selection of those who can sell performance, reliability, and good engineering will do much to render frequent changes unnecessary. Too many changes arouse suspicion in the mind of thinking customers. —CHARLES F. HENRY.

A MANUFACTURING firm is divided into four major divisions: Financing, selling, engineering, and manufacturing. After the initial financing, the most important of the four functions is selling.

The life and prosperity of a firm depends upon the ability of its sales force to keep its personnel occupied. Its engineering staff should be willing to design anything within reason that the sales department can sell, but of course it must be so designed that the shop will be able to manufacture it economically.

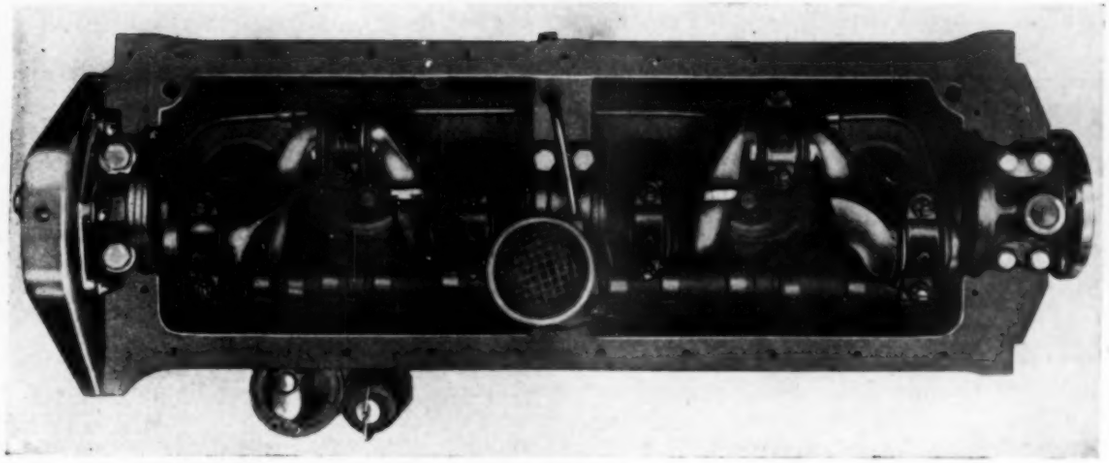
The sales department is not only justified in asking for changes, but is in a better position than any other department to suggest them. The engineering and manufacturing departments should not be judges of the wisdom of any change, except from an effeciency and cost standpoint. After these have been pointed out, the managing executive is presumably competent to decide the advisability of the change, and also to settle any question as to price increase owing to increased cost of production.

There are numerous instances where the refusal of the engineering department to make changes asked for by the sales force have proved costly. A large automobile concern announced that after a careful study of the question, its engineering department had reached the conclusion that there was no real merit in four-wheel brakes, and therefore it was making public announcement that its product would not be equipped with them. The sequel to this announcement was a serious loss in advance sales—and the final installation of four-wheel brakes.

On the other hand, both engineering and manufacturing departments should oppose vigorously changes to please a particular customer, or the sale of a few devices of special design. As a rule, the sales or executive department has no conception of the real cost of special parts.

Before a change is authorized, an inventory should be made of the parts on hand that will be made obsolete, and a final disposition made of them. It is the usual practice of the engineering department to say, "we will need these for repair parts" or, "we will use these on another design," and they lie in stores indefinitely.

—G. B. EVANS.



Bottom view of Chevrolet crankcase, showing the sturdy three-bearing crankshaft

Chevrolet-Six Design Based on Economics

By Alex Taub
Research Engineer, Chevrolet Motor Company

Sound engineering practice employed in effort to give maximum utility per dollar and low upkeep cost

TO BE successful, an automobile power plant, particularly in the low price range, must represent maximum utility per dollar to both user and manufacturer. For the user, it must be capable of delivering power over the greatest period with minimum expense for upkeep. For the manufacturer, it must be adaptable to easy production in large volume, with maximum inherent facility in foundry, forge, machine shop and assembly. Ideals as to finish alone are not enough; they must include function and appearance.

When an effort is made to increase the utility of a product, it is necessary to consider many viewpoints, including that of the sales organization with its public contact and field experience, the manufacturing department with its desire to facilitate production, and the engineering department with its technical ideals and performance requirements.

In designing the Chevrolet power plant it was foreseen that the future demanded improved smoothness and performance with greater durability. Also, that "big car appearance" was wanted. Improved performance includes higher maximum speed, more rapid acceleration, and better hill climbing ability. Greater durability means longer life for main bearings, connecting rods, etc. Also, a longer period of gas tightness for the valves is necessary if the desired performance is to be sustained indefinitely under the hard service conditions encountered.

Condensed from a paper presented before the Metropolitan Section, Society of Automotive Engineers.

In respect to smoothness or freedom from vibration the inherent fault of the four-cylinder engine is well understood. Efforts to offset this evil mechanically with harmonizers, dampeners and special motor mountings have either increased complication or the relief has been temporary in character. Aluminum pistons modified the difficulty, but did not eliminate it.

It was perfectly logical to assume, from the facts at hand, that increased life for all parts would ensue if vibration could be minimized. It was logical to turn to a "six," since this type of engine is free from the destructive and annoying secondary forces which are the major source of vibration in a "four."

To give the desired performance throughout the life of a power plant, it was necessary to increase piston displacement. The gains made by this method are permanent. To increase the piston displacement of a four-cylinder job seemed to lead us into greater difficulty. The amplitude of the vibrations were increased; so, too, were the explosion reactions. Although we are able to control combustion to some degree, the four cylinder bulk charge was large already and difficult to control thermo-dynamically. Considerable improvement could be made by stiffening up engine and chassis parts, but the increased weight and cost would make the power plant economically unsound for our price range. In other words, the result per dollar would not be a maximum, hence our objective would not be achieved.

Logically, we turned to the six, since this type of

Table I. Comparative Value of Various Performance Factors in Different Four- and Six-Cylinder Engines

Combination	Cu.Ft. per Ton Mile	Axle Ratio	Cu.In. Piston Displacement	Cu.Ft. per Car Mile	Compr. Ratio	Rev. per Mile per Hour	Piston Velocity Ft. per Car Mile
A—6-cyl. . .	109	5.6	160.3	179.3	5.75	64.4	2,899
B—4-cyl. . . .	104.6	3.77	200.5	152.9	4.4	44	1,867
C—6-cyl. . . .	105	4.56	176.3	167.7	5.1	54.17	2,099
Chevrolet-6..	100–104	3.8	194	154.1	5.0	45.8	1,717

engine with its 33 per cent smaller charge per cylinder lends itself to better thermo-dynamic results. The six also gives more elbow room for expansion in overall size.

Even assuming that the four could be inherently balanced as well as the six, we still would be forced to consider the violence of the torque reaction when the engine explosions per minute are in phase with the period of the sustaining members. The higher the car speed at which this occurs, the more objectionable it is.

Note also, from Fig. 1, that the low speed characteristics of the six are considerably better than those of the fours. This insures fairly good "lugging" ability in addition to improved acceleration. Furthermore, this gain is established for the six without sacrificing good acceleration and economy at high speed.

The fours whose b.m.e.p. curves are given in Fig. 1 are widely different, yet the character of their performance over the speed range is similar. Both engines have seen service in the low-price field, and hence it is to be assumed that they have been satisfactory as power plants. The lower output at slow speeds made them acceptable from the torque reaction standpoint, and the lower output at high speed permitted a low weight structure which would have been inadequate had the power output been as high as indicated for the six. Thus the six forces its way into consideration by its smooth operation and performance throughout the speed range.

In changing from the four to the six cost has not advanced, however, at the same rate as utility, and in addition "big car appearance" has been attained with the six. In anticipation of this the chassis was lengthened last year to provide good proportionate hood to body length.

The effect of additional weight upon cost of this power plant has been controlled by careful consideration of metal distribution. This was important because weight has a controlling effect upon cost, performance and durability.

Reduction in weight is the most difficult project that an engineering department can undertake, but improved performance can be effected only by a reduction in weight to power ratio.

In the finished cylinder block light unsupported walls are a constant source of trouble from deflection and resonance, and also warpage under heat. Therefore, these walls should be supported or short, or thick enough to preclude troubles. Short walls of medium thickness give the lightest satisfactory construction.

In the machine shop the problem is machineability. The block must be sufficiently sturdy to permit accurate and fairly rapid machining. This may require greater

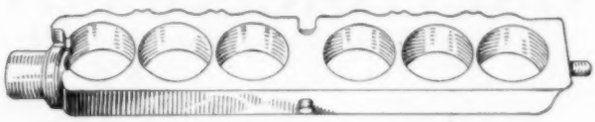
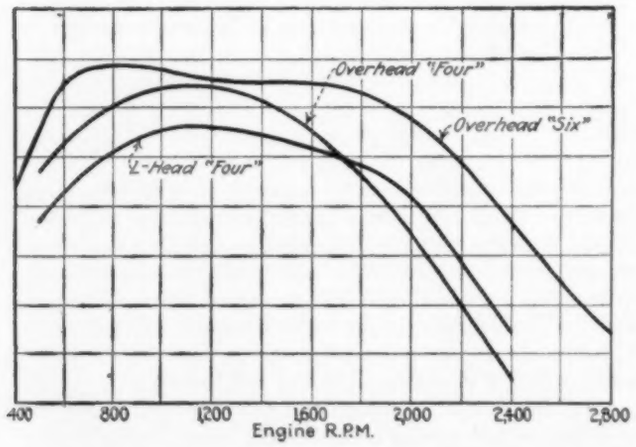


Fig. 3—One-piece water jacket core used in casting the Chevrolet cylinder block

rigidity than is necessary in the finished product. If accuracy is sacrificed, the construction must be changed or weight added.

In the foundry, we find other problems. Iron at the cupola spigot may cost 2c. a pound, yet the final casting cost may be 4c. to 7c. a pound. The difference is in the labor and burden involved in molding, in cleaning castings and in scrap. If the walls are too thin to cast with minimum scrap, then weight saving probably increases cost. If the molding is complicated by construction, increased cost and scrap hazards result. If weight is added in such a manner as to simplify molding and reduce the possible scrap, it can be added for little or no cost.

The general effect of metal distribution upon cost was considered carefully in all parts of the Chevrolet power plant, with the result that utility was improved greatly while a slight reduction in cost was also effected.



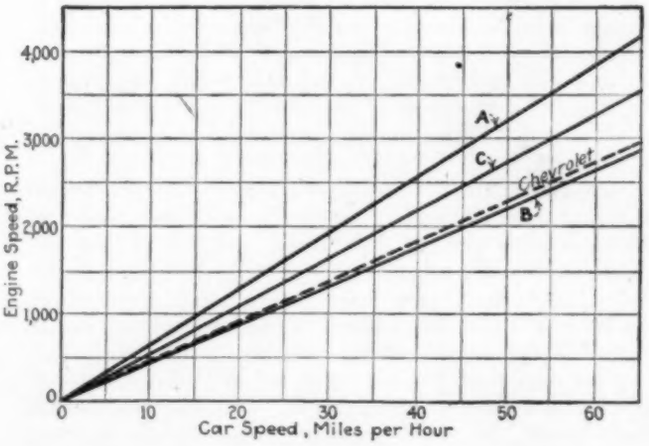


Fig. 1—Brake mean effective pressure curves of two four-cylinder engines and one six-cylinder engine. Fig. 2—Curves indicating relative durability factors of four engines

The improved performance desired could be obtained with a relatively small power plant of high efficiency, or a larger engine with reasonable efficiency, but the larger engine assured maximum performance for the greatest number of car miles.

To determine piston displacement, a performance factor based upon cubic feet displacement per ton mile was used, for this factor involves only direct dimensional and mechanical ratios and weight. Determination of the performance factor was accomplished by comparing various combinations of the major items given in Table I.

Combination A gives a high performance factor, 109 cu.ft. per ton mile, but involves an axle ratio of 5.6 and a relatively small engine. The cubic feet per car mile is likewise high, 179.3, denoting bad potential economy. A compression ratio of 5.75 to 1, however, tends to overcome this handicap. This combination involves also a small high-efficiency engine, and a low axle ratio, but the price paid is a piston velocity 2,899 ft. per car mile and an engine speed of 64.42 revolutions per mile per hour.

Combination B indicates a good performance factor of 104.6 obtained with an axle ratio of 3.77, evidently a fairly large engine, yet the economy factor is very reasonable at 153 cu.ft. per car mile. The compression ratio, 4.4, however, is low. This combination is undoubtedly in the class of large engine, low efficiency, and high axle ratio, but the advantage in durability is obvious as indicated by a piston velocity of 1,867 ft. per car mile and 44 r.p.m. per mile per hour. Combination C indicates a compromise giving a good performance factor, 104.6, evidently a medium size engine and medium axle ratio. The attempted efficiency is reasonable as indicated by the 5.1 compression ratio. The economy factor is not low at 167.7. Yet this compromise has not much to offer in potential durability for the piston velocity is 2,100 ft. per car mile and the speed over 54 r.p.m. per mile per hour.

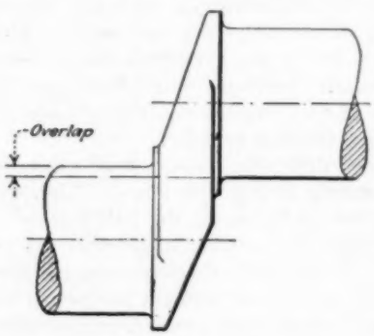


Fig. 4—Section of the Chevrolet crankshaft showing the overlap of main and crankpin bearings

These three combinations give some idea of the wide variations that exist in practice.

The fourth combination shows the relative performances and durability factor of the Chevrolet power plant. The performance factor is 100 to 104 cu.ft. per ton mile, depending on the type of body. An axle ratio of 3.82 to one gives an economy factor of 154 cu.ft. per mile, and durability factors represented by 46 r.p.m. per mile per hour and a piston velocity of 1,717 ft. per car mile. The attempted efficiency as represented by the compression ratio is reasonable.

In Fig. 2 is shown the relative position of the durability factors. Obviously, the Chevrolet factor selected represents good practice. The piston displacement to obtain this ideal is 194 cu.in.

This comparison is significant in the light of present day car speeds in the low price field. The speeds indicated by line A result in internal stresses and loads dangerously high and require extreme care in lubrication, even under ordinary service. Curve B certainly looks rational and obviously represents no great hardship in maintenance. Curve C, which is the compromise combination, is fairly high but certainly not too high.

An interesting side light on these comparisons is that Combination A gives the least satisfactory actual performance, yet the potential performance factor is highest. Therefore, it is logical to assume that the efficiency of this power plant is low.

Once the piston displacement range and performance of the power plant have been determined, the valve size for a desired lift is determined automatically. Therefore, the first consideration for determining the engine length must be provision for all the valves and ports.

Table II. Average Pressure in Pounds per Square Inch on Chevrolet Crankshaft Bearings

	Bearing Area, Sq.In.	600 R.P.M.	1,800 R.P.M.	3,000 R.P.M.
Connecting rod....	2.75	138	251	524
Front main.....	3.43	155	219	405
Rear main.....	4.48	118	155	310
Center main.....	4	264	325	676

Manufacturers of low priced cars and also of certain makes of higher priced cars heretofore have made the engine as short as possible. To do this, the practice has been to leave no water space between the intake valve seats or between the intake and exhaust valve seats.

Now since engine performance depends upon the degree of gas tightness of the valves, it is obvious that maximum performance cannot be maintained when the valve seats go out of round. When it is realized that the metal temperature of the block around the exhaust valve seat rises above 500 deg. F. and that of the intake valve seat only to 200 deg. F., the necessity of having a cooling medium between the two seats is evident.

Power plants without water between exhaust and intake valves are being produced today and, wherever found, the engine fails to maintain its performance after reasonably hard driving.

If sustained performance is desired, adequate provision must be made for valves, port metal and water. The water space also must be sufficient to permit the foundry to produce the casting at minimum cost.

If valve seats are cooled improperly, the valves will be under-cooled. This usually means high priced valves because heat resisting material is required. But even valves that do not warp themselves do not give desired results if the valve seats warp, as they must if uniform expansion is not assured by proper cooling.

Having decided upon the number of cylinders and established the length of the engine, the largest bore that can be used with due allowance for cylinder walls and water space between barrels gives best results from an economic standpoint.

In the Chevrolet power plant uniform expansion of cylinder walls is assured by providing water space completely around cylinder barrels. Gas tightness, as far as the piston is concerned, is a major item in performance. As with valve seats, when the seal is disturbed, sustained maximum performance is impossible. Control of lubrication also becomes complicated. Fortunately, the prac-

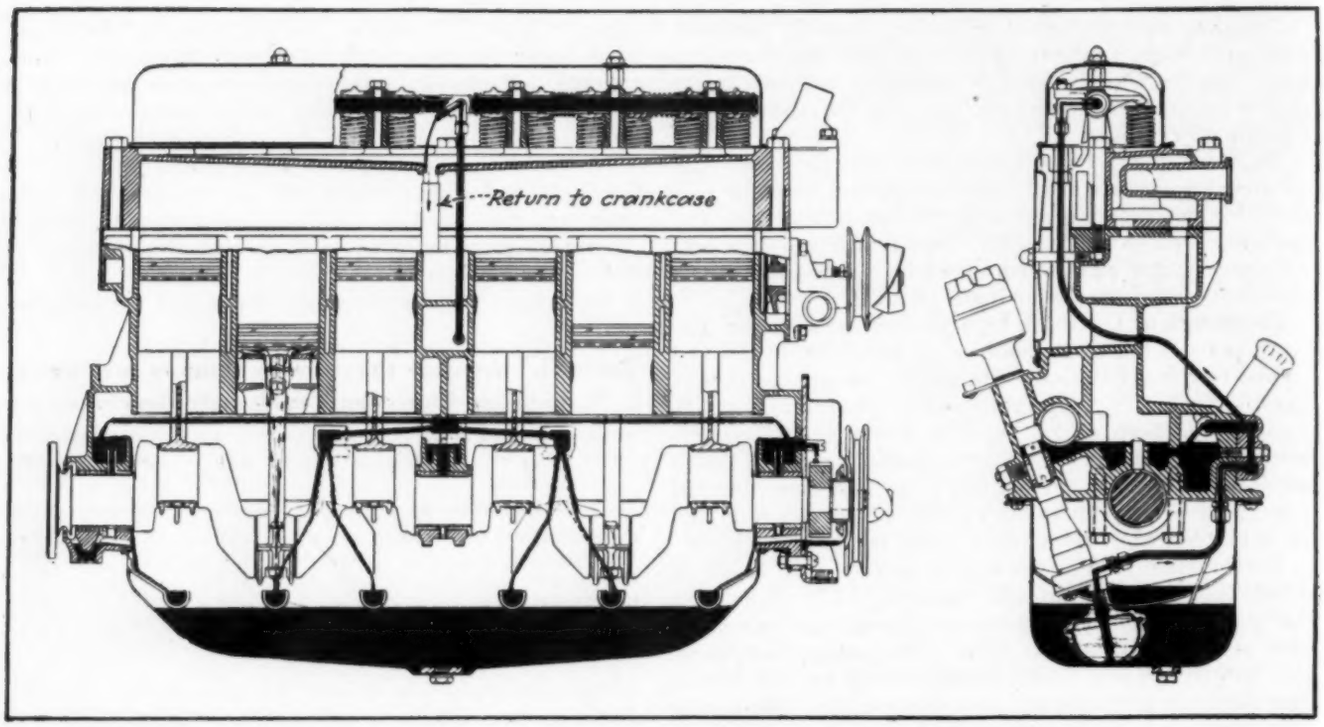


Fig. 5—Sectional views of the Chevrolet engine, showing arrangement of the lubricating system

tice of making Siamesed cylinder barrels has been almost outlived. When water space is provided, however, it must be large enough to insure that water will remain all around the barrel.

In Fig. 3 is shown a water jacket core made in one piece, the core box being split at the top. This core was developed to obtain positive assurance that water will completely surround cylinder barrels. The usual practice is to split this core on the barrel centerline, making a joint at the thinnest part of the core, the result being fins in the casting where such fins will do most damage.

After due allowance for water jacketing was made it was found that the largest bore practicable would be $3\frac{5}{16}$ in.; hence, for a 194 cu.in. six-cylinder engine, the stroke figured $3\frac{3}{4}$ in., which is short.

An ideal crankshaft is one that ensures maximum rigidity, highest period position and minimum period duration for the fewest pounds of steel. A short stroke helps to realize this ideal. In the Chevrolet crankshaft torsional periods of any moment are beyond the driving range.

With the relatively large bore, it was possible to use a large crankpin and not interfere with removal of piston and rod assembly upward through the bore. The rugged three-bearing six-throw crankshaft finally evolved is shown in the headpiece. It is worthy of note that main bearings and pins overlap, thus eliminating unsupported short cheeks. See Fig. 4. There were sound reasons for selecting a design involving only three main bearings.

Unfortunately, the early use of a three-bearing six-throw crankshaft involved a long stroke or light sections, or both. It was known then as now that the three-bearing shaft offered the best balance because the six is a combination of two three-cylinder engines, each three inherently balanced. This condition of balance is not interfered with when each group of three is arranged between bearings. Some manufacturers, however, added another bearing to support a relatively flexible shaft, but it was found impossible to obtain reasonable life for the intermediate bearings since the balance then was through the bearings instead of between the bearings. Shafts were constantly increased in size to offset the abnormal wear at the intermediate bearings, but little good was accomplished because the increase in rotating weight kept pace with the increased bearing surface.

To overcome this difficulty, some manufacturers adopted the seven-bearing crank for sixes. This gave ideal support but increased torsional flexibility since the shafts were made as light as possible in an effort to prevent excessive cost. Then came the question of alignment. Seven bearings were more difficult to line up than four or three. The difference in alignment was manifest, especially as between hot and cold engines. One manufacturer of cars in the highest price class fitted the four intermediate bearings of the seven-bearing crank loosely enough to allow for this condition. Thus, there were seven supports but only three bearings.

In the meantime, the proponent of the four-bearing shafts adopted counter-weights as a means of minimizing bearing wear, which they accomplished. These weights served, however, to bring the torsional vibration period down into the driving range. This in turn brought on the present harvest of dampeners, harmonizers and balancers.

Chevrolet investigation brought out the fact that, by concentrating the rotating weights as near the center of crankshaft as possible, the resultant bearing loads would be reduced considerably and the rigidity correspondingly increased. Rigidity also was increased by designing the crank with overlapping main bearing and crankpin, because the "accordion action" of the shaft was eliminated.

Further investigation brought out the fact that the shorter stroke served to bring the objectionable torsional periods outside the driving range. A shorter stroke reduced the piston velocity for any given speed and when the engine drives through an axle ratio of 3.82 to 1 or 46 revolutions per mile per hour, the resultant durability factors attain a maximum value.

Thus, by careful consideration of all factors, a three-bearing crankshaft was developed that virtually eliminated deflection by inherent rigidity, gave inherent balance between bearings, reduced bearing loads, brought torsional vibration outside of the driving range, and gave low piston velocity. Add to this the simplicity of a three-bearing crankcase, and the result is an outstanding example of getting maximum results per dollar.

Examination of the bearing loads and crankshaft stresses afford interesting data. Table II gives the mean or average pressures per square inch for connecting rod and main bearings. The loads are unusually low. The car speed at 3,000 r.p.m. is 65 miles per hour, yet even at this speed, the bearing loads vary from 310 to 676 lb. per sq.in.

The maximum stress in No. 5 crankpin occurs at 600 r.p.m., and full torque, yet even under these conditions the factor of safety is more than 5 to 1. The stress decreases with speed, and is lowest at 2,550 r.p.m., which corresponds to 55 miles per hour, where average high speed driving is most likely to occur.

The fiber stress at the long cheek also is maximum at 600 r.p.m. and the full torque factor of safety is more than 6 to 1. The stress at this point also decreases as the speed rises. In this case, the minimum value occurs at 2,800 r.p.m. or 62 miles per hour.

In the short cheek, generally considered the weakest point in a crankshaft, the maximum fiber stress, also at 600 r.p.m., still gives a factor of safety of about 5 to 1. The stress at this point too decreases at high speed, reaching its lowest value at 2,675 r.p.m. or 58 miles per hour.

If centrifugal and reciprocating loadings were higher, as would be the case if the stroke were longer, then crankshaft stress would be much greater for the high car speeds. All factors appear to favor a short stroke.

This crankshaft actually represents the maximum rigidity per pound of steel, of any crankshaft used in the industry today. Further, it distributes the explosive and dynamic loads on its bearings at extremely low unit pressures and finally the internal stresses are lowest at high car speeds. Thus the shaft satisfies the designer. In the machine shop, the inherent stiffness of the shaft facilitates accurate and rapid handling through machining and grinding operations. Hence the shaft satisfies the manufacturing department. The forge shop naturally is satisfied with this simple short throw shaft since the shaft can be forged with the pins in index, thus eliminating operations otherwise required.

In Fig 5 the Chevrolet lubricating system is illustrated. Positive distribution of oil to each connecting rod trough is accomplished by individual take-offs from the main oil line at small pressure reservoirs.

Pockets over the main bearings maintain the oil level above stand pipes. These pipes register with a system of grooves in the main bearings that distribute the oil. The stand pipes are so located that sediment chambers collect solids which otherwise might interfere with good lubrication.

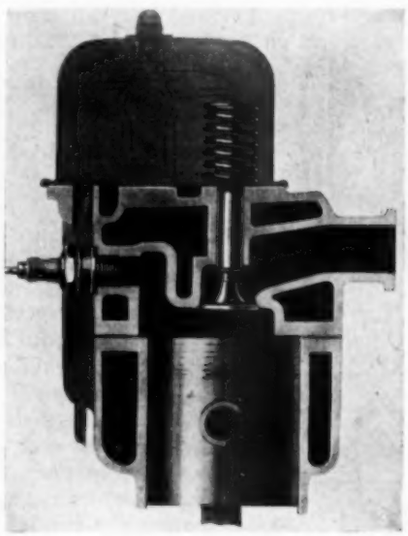


Fig. 6—Vertical section through the Chevrolet cylinder, head, showing the novel shape of the combustion chamber

Positive lubrication of the camshaft bearings is accomplished by making the oil level in main bearing pockets higher than the bottom of the camshaft bearings. A chamber leading directly into the lower part of the camshaft bearing is provided to supply lubricant at this point.

A semi-positive feed into the connecting rod bearings is accomplished by a special design of dipper. A stoboscopic examination proved that this dipper serves also as a bucket and carries the lubricant within itself to a point on the down-stroke of the rod where inertia injects the oil into the rod bearing. Thus, the connecting rod bearing is served twice in every revolution.

Lubrication of cam profiles and tappets is accomplished by locating these parts on the throw-off side of the connecting rod splash. Cylinder bores and piston pins are lubricated by the rod throw-off as is the case with most oiling systems.

Rocker arm shaft and valve stems are lubricated directly by connecting the hollow shaft with the low pressure or relief side of the oiling system. This, in combination with a special overflow at the rocker arm shaft, insures that the overhead system will be filled with oil at atmospheric pressure.

Thus every phase of power plant lubrication has been given adequate consideration. There are features incorporated in this system that heretofore have been considered unattainable in the low price field.

A valve gear of the overhead type is retained in the new engine because it provides high volumetric efficiency, improved manifolding and a very desirable accessibility of the adjusting mechanism. Such a valve gear certainly is not favored by lowest cost, but it does represent a high utility per dollar. An organization accustomed to building this type of engine is able to produce it at a cost that is very attractive in view of the mechanical advantages that ensue.

Manifolding is improved because it is, in the main, down draft; hence it does not permit pools of gasoline to form. Accessibility is excellent. To minimize noise it was necessary to take advantage of the natural opportunities that exist in the mechanism itself. Since a rocker arm is employed, a lever arm ratio such as to decrease materially the necessary direct lift of the cam profile was chosen. The extremely small flank radii of the cam, also the type and length of ramp chosen are potential anti-noise elements. A generous dwell also is provided at the cam nose. This naturally provides improved volumetric efficiency.

With a well-designed cam profile as a basis, noise can be caused only by excessive clearance. If this clearness is constant and the cam is designed to suit, operation will be quiet. Constant clearness can be secured by compensating the expansion of the valve operating mechanism, the valves and cylinder block.

Push rod expansion is controlled by the air temperature within the side cover. This air temperature can be lowered by ventilating or raised by increased sealing. The cylinder block expansion is affected by the length

of the water jacket. Exhaust and intake valve expansion depends in part upon the length of the valve stem guides. Considerable time was spent in determining the final combination, but the only outward evidence of this work is shown in the difference in length of the guides employed.

The combustion chamber of the Chevrolet engine is shown in Fig. 6. Its shape was made unusual for definite reasons, the objective being low detonation and low shock characteristic. An L-shaped form of combustion chamber was selected partly to avoid a compact chamber. If this chamber were in one plane, it would overhang the block and it would be difficult to locate the spark plug correctly. Therefore, the chamber was "folded up" into the cylinder head where there is room. This arrangement also permitted a convenient location for the spark plug.

Explosion time is an important element in controlling roughness in combustion. Now a turbulent charge decreases explosion time, but if turbulence can be impeded, somewhat greater explosion time is gained and operation becomes smoother. Since the Chevrolet combustion chamber has a tortuous shape, its retarding effect on turbulence is considerable. This is proved by the relatively long spark advance required for maximum power operation.

The 5 to 1 compression ratio selected gives a gage pressure of 100 lb. per sq.in. This compression certainly is not low and yet is not sufficiently high to cause any operating difficulty with the type of chamber selected and can be maintained over a long period.

Performance curves of the engine are given in Fig. 7. Brake horsepower is 23.5 at 1,000 r.p.m. and reaches a maximum of 46 at 2,400 r.p.m., which is a relatively low engine speed. The power required to drive the car is shown in the lowermost curve. The difference between the two power curves is indicative of the reserve for acceleration. Note that the brake mean effective pressure is a maximum at 800 r.p.m. at which it reaches 98½ lb. per sq.in. This figure is high for any price class and indicates efficient operation. A high b.m.e.p. necessitates good volumetric, good sealing or gas tightness and efficient combustion. These curves prove that the construction features described have brought the results desired for the engine.

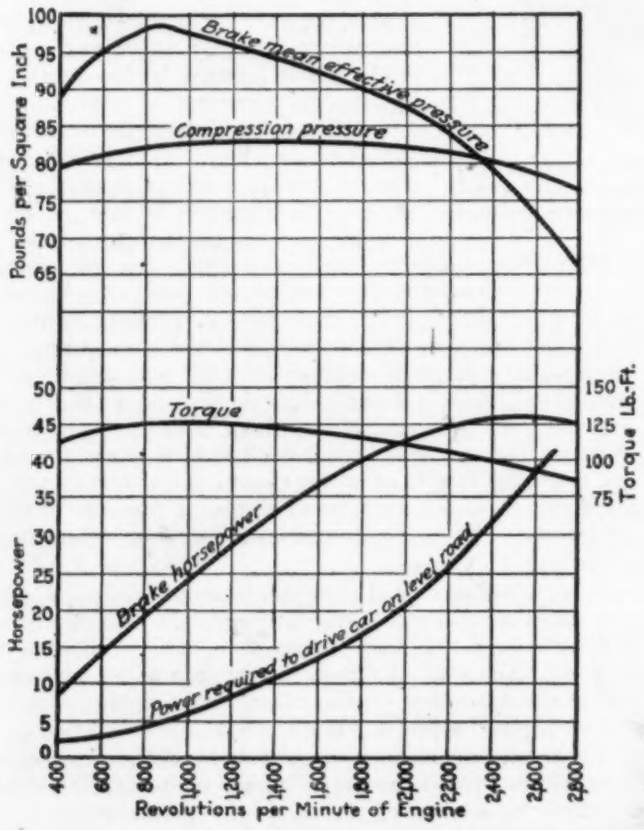


Fig. 7—Performance curves of the Chevrolet six-cylinder engine

The objectives sought have been attained at a cost heretofore considered impossible in a six cylinder engine. This low cost was brought about by an intensive study of the details of this engine by the Production Department, foundry and forge shop. New methods of handling material in every phase of operation were devised. Throughout the development period, the design was molded to suit various situations. The problems met and overcome in preparation for the production of this engine are a greater triumph of engineering than the engine itself.

Practical Contact for the Designer

By Wm. F. Kunz

THE men employed in large drafting rooms, where the work is largely theoretical or developmental, lose much when they do not have actual contact with the methods of production. A draftsman working for a small concern, that is, a firm whose engineering personnel may consist of from two to five draftsmen, has far greater advantages for acquiring knowledge through practical experience than if he were submerged in a crowd of from 20 to 40 men, where only the gang leader and chief have practical connection with the work.

In the small plant the draftsman may be called upon to furnish theoretical designs for a customer's inquiry, or, armed with rule and calipers, he may invade the recesses of the shop to jot down preliminary sketches, or new kinks to speed up production. He may even be called upon to furnish technical drawings for the new catalog. But it is in the shop environment where he can work largely on his own initiative and save time and material for his firm. These two elements are the real money factors.

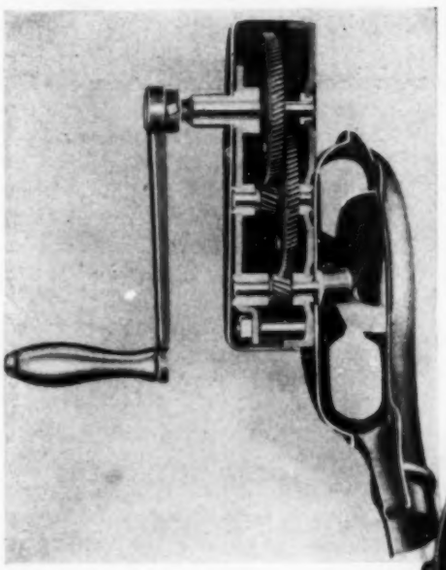
In new designs of product, with standard tap, die, gage, and chucking equipment in reference-sheet form, he has access to the toolroom, or store-room, to search for a tool or material already on hand for utilization to the purposes of the new design, in preference to specifications of tools and materials which would necessitate expensive purchases. Of course, a progressive concern must renew and increase its equipment constantly, and sometimes the strict adherence to usage of tools and material already on hand may be most expensive in the end. This requires judgment on the part of engineer or draftsman. But where standard thread cutters, or other equipment of like nature can be purchased in the open market it is foolish and costly to specify tools which will require the services of the toolmaker.

Requests for changes in design from the shopmen must be handled carefully to insure their continued cooperation, whether or not a suggestion is accepted. Lack of tact or diplomacy on the part of the designer will soon lose every vestige of the shopman's desire to co-operate in tool or product design. Constant contact with practical men will be mutually advantageous.

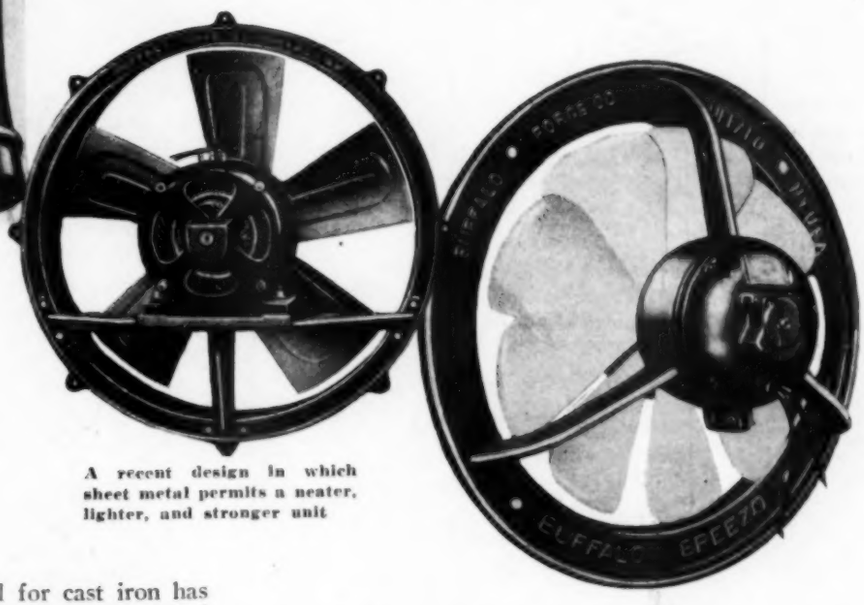
Sheet Metal *Supplants* Cast Iron

IN FANS AND BLOWERS

How such products as portable forge blowers and ventilating fans have been improved by the substitution of sheet metal for castings



Cross-section of an early forge blower design in which both cast iron and sheet metal were used. Right—Ventilating fan mounted on a cast-iron frame, and with brackets of the same material



A recent design in which sheet metal permits a neater, lighter, and stronger unit

SUBSTITUTION of sheet metal for cast iron has progressed greatly in the last few years, a typical example being found in the simple mechanism that makes up the portable blower which the Buffalo Forge Company began to manufacture over a half century ago. In those days cast iron was the natural material that the designer designated for everything except the shafts and bearings. Developments in the use of sheet steel have changed this, however, and the parts for the blower unit are now made on presses. The fan and gear cases are shown at *A* and *B* in Fig. 1, the gear case cover being shown at *C*, while *D* is the frame that supports one end of the gear shafts. As shown, the gear case is held to the outer half of the blower case by four rivets.

Although the change from cast iron to steel left the various elements in their same relative position, considerable redesigning was necessary to utilize the new material to the best advantage and reduce machining operations. The fan, for example, *E* in Fig. 1, is now a steel stamping having an inserted hub that is a screw-machine product. The gears are blanked from steel plate and have the teeth cut on machines of approved type. The pinion gear is cut on a screw-machine blank that also forms the shaft for the fan.

Another, and considerably larger, example of the passing of cast iron in the product of this company is seen at the center and the right of the headpiece. Both are motor driven fans, but in the first case the circular mounting is of cast iron with cast-iron motor bracket

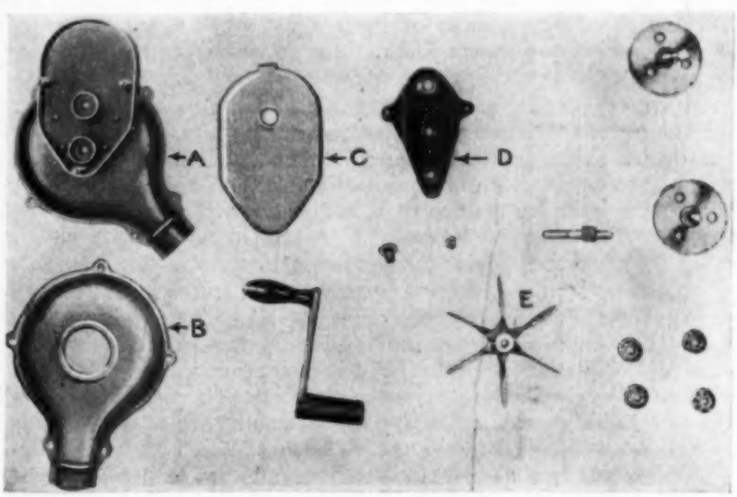


Fig. 1—Parts of the blower for a portable forge re-designed and made of sheet metal die-formed to the desired shape

arms bolted to it, while in the other the entire mounting is of sheet steel, cut and formed to shape and the three arms welded to the fan ring. Furthermore, the motor has been redesigned and is clamped in a steel band which joins the inner ends of the three arms, making a neat and substantial construction that locates the motor and fan in its proper position and permits easy removal and replacement.

Details of this construction are seen in Fig. 2 in which the shapes of the sections, the method of locating the arms in the ring, and the way in which the bolt holes are reinforced, are plainly shown. It will be noted that the

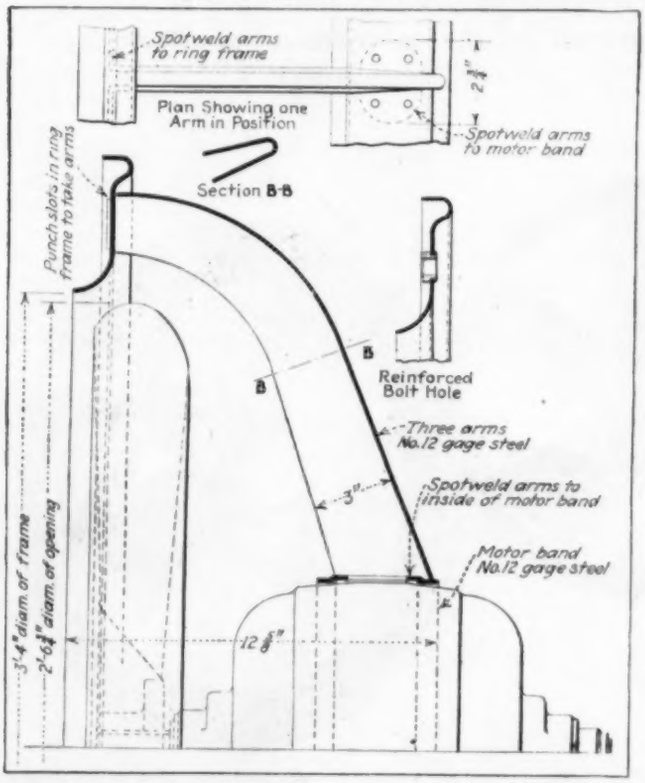


Fig. 2—Showing the method of extending the ends of the arm through the ring and spot-welding them

outer ends of the arms go through a slotted opening in the outer ring and that the ends are flared at 90 deg. to give added security and a substantial area for welding.

Building up and assembling the fan for this unit is also an interesting example of the way in which sheet metal is replacing castings in this line of manufacture. All parts except the hub, which forms a bearing for the shaft, are of pressed steel. The center disk, to which both the hub and blades are riveted, is of 14-gage steel. It is dished to add stiffness, and to bring the blades in proper alignment. Each blade is fastened to the disk by three rivets, and the assembled unit is given a test for balance.

Not only are these units cheaper to manufacture, but it is much easier to secure uniformity and balance, and they can be shipped with less danger of breakage. As examples of modernization in design and the use of material, these fans suggest possibilities throughout a wide range of products.

Two decided advantages are cited in connection with the change from cast iron to steel. The loss from breakage, which was considerable with cast iron, is practically eliminated, and production has been increased as much as 1,000 per cent, or ten times the former rate, in some cases.

Before the Days of Blueprints

By H. S. Ashton

BLUEPRINTS have been in universal use for many years, yet comparatively speaking, they are not so very old. They did not come into geenral use until the early 80's. The late Alexander Gordon, president of the Niles Tool Works, and myself happened to be in a machinery house in Philadelphia, in 1875. One of the proprietors showed us a blueprint he had received from France and asked us if we knew how it was made. Mr. Gordon took the address of the sender and wrote him for information on the process.

Before that drawings were traced on what was called "vegetable" tracing paper. The drawings were made generally on Whatman's cold-pressed drawing paper, dampened, and glued at the edges to the drawing board. When the paper became dry, it was as taut as a drum head and as free from wrinkles. The paper, generally 27x42 in., was covered with drawings of all the parts that could be crowded upon it. No thought was given to sequence of arrangement. Outlines were inked in black, and dimension lines and arrow heads in red.

Dimensions did not include limits or tolerances. Such things had not been heard of. The workmen were familiar with the pieces they were making, and their relation to mating parts. They knew which fits were to be running, tight, or loose, and made them accordingly to the best of their judgments. Not all drawings were dimensioned, however. In some shops, machinists were allowed to take off the sizes of the parts by scale measurement. Tracings were made for use in the shop. Like the drawings, the outlines of the parts were in black and dimension lines in red.

These facts had a great deal to do with the slowness of the blueprint's adoption. Since there could be no differentiation in color between outlines and dimension lines, it was thought that confusion would result and perhaps lead to mistakes.

Tracings were mounted on boards with white shellac, and, when dry, were given one or two coats of the same varnish to preserve them. Before mounting the tracings, the boards were rubbed with chalk to counteract the yellow of the tracing paper.

When a drawing of a machine or of any of its parts was to be sent to a prospective purchaser, a tracing was made, generally on tracing cloth, and was sent to him. This procedure had to be repeated each time a tracing was sent out.

There was no liquid drawing ink in those days. Each draftsman's first duty in the morning was to grind his supply of ink in water for the day. The ink came in sticks and a stick of the best ink cost ten dollars, but it would last for years. The ink, of course, was not waterproof, and woe betide the draftsman who did not keep flies away from his freshly inked work.

When blueprints first came into use the paper was prepared after dark, generally at home, and was kept in a dark room until it was bone dry. Since it lost its sensitiveness after a few days, it was neecssary to prepare a fresh supply once a week or oftener. Such paper had to be exposed under a tracing for about five minutes in bright sunlight in order to get a good print.

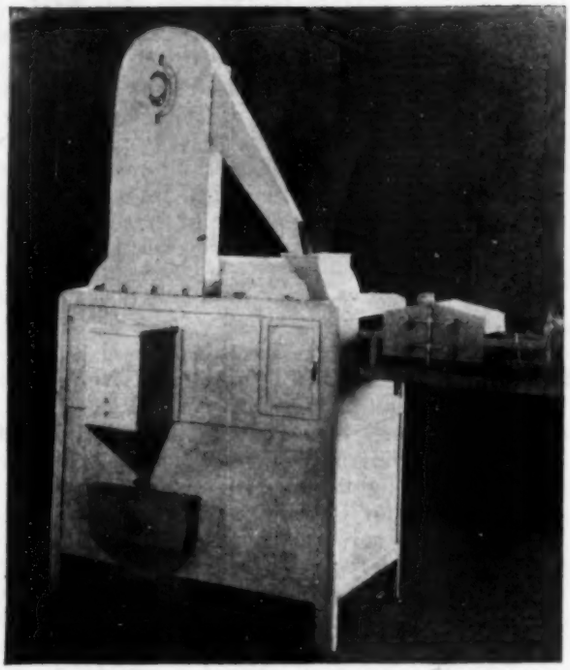


Fig. 1—This sugar-sanding machine, formerly built up largely of cast-iron parts, was redesigned for arc-welded construction, and presented a more pleasing appearance, while costing no more to make

REDESIGN

for

WELDED CONSTRUCTION

By J. M. ROBINSON
Detroit District Manager,
The Lincoln Electric Company

Appearance of a machine was improved and some definite advantages secured without increased cost or any impairment of its mechanical functioning

DESIGNERS and builders of machinery recognize the physical superiority of arc-welded steel construction for many purposes, especially the greater strength and rigidity imparted by its use in machine construction. However, some concerns have been reluctant to adopt this type of construction, due to the belief that physical appearance would be sacrificed.

A sugar-sander, a machine for use in bakeries, built by the Baker Perkins Company, Saginaw, Michigan, offers an excellent example of improvement in physical appearance effected by the use of arc-welded steel construction. The accompanying photograph, Fig. 2, shows the machine before redesigning. Cast iron was used extensively in its manufacture. The problem before the makers in redesigning the machine, was to meet the following requirements:

1. To redesign an existing machine which was structurally weak, and thereby induced wear in the mechanism through misalignment, and liability to breakage in shipment.
2. To produce a new machine in the shortest possible time.
3. To make the new machine more pleasing to the eye than its prototype.
4. To reduce the noise of the mechanism to a minimum.
5. To produce a better machine for the same or less cost than the original.
6. To produce a design in which the moving parts were perfectly guarded, while at the same time readily accessible.
7. To maintain an outline which would simplify painting and also simplify cleaning.
8. To develop a machine which could be kept sanitary and immaculate.
9. To produce a machine which could be quickly and cheaply crated for shipment, readily reassembled after shipment, and quickly disassembled for repairs.

The photograph, Fig. 1, shows the result of redesigning for arc-welded steel construction. The machine consists of a rotating drum, perforated for part of its length, and provided with a helical channel on the inner periphery; a bucket elevator feeding into one end of

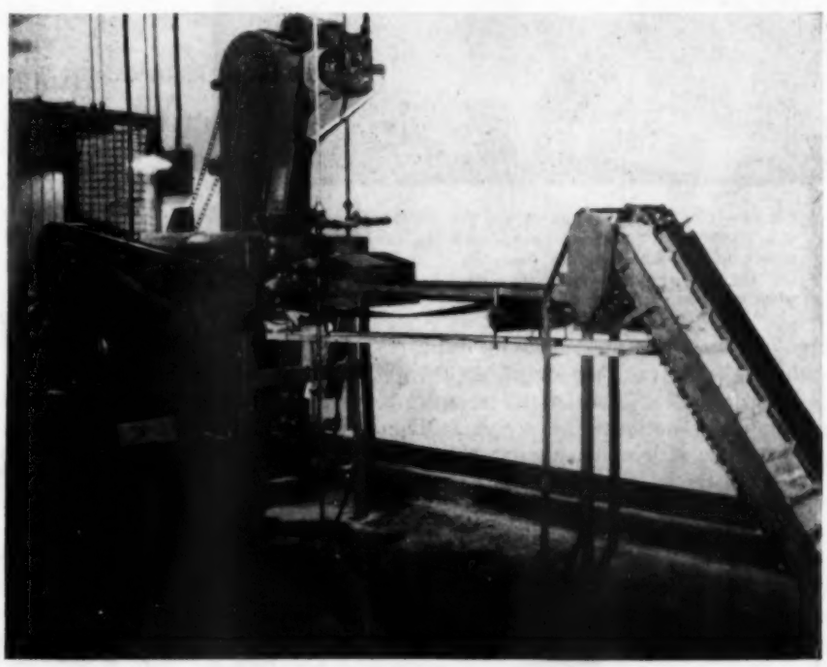


Fig. 2—Before it was redesigned, the sugar-sander, a bakery machine, was bulky and unattractive, and lacked several desirable features

the drum; a hopper for feeding material into the elevator; the necessary motor, speed reducer and gearing for actuating the moving members, and the chains and sprockets for connecting the drive to the moving members. A conveyor for feeding material into the drum is a separate part of the equipment.

To obtain the best appearance, all welding, as far as possible, was done on the inside of the framework. Instead of using structural angles for the corner members, sheet stock was used and bent to a right angle with a liberal radius. Two important reasons governed this point:

1. The rounded corners are not only more pleasing to the eye, but to some degree, prevent wearing off the enamel finish at the sharp corners, when wiping down the surfaces during cleaning.

2. The fillet at the outer extremities of structural angle legs would not give a square finish to the panelling, without the extra labor of filling the resulting grooves.

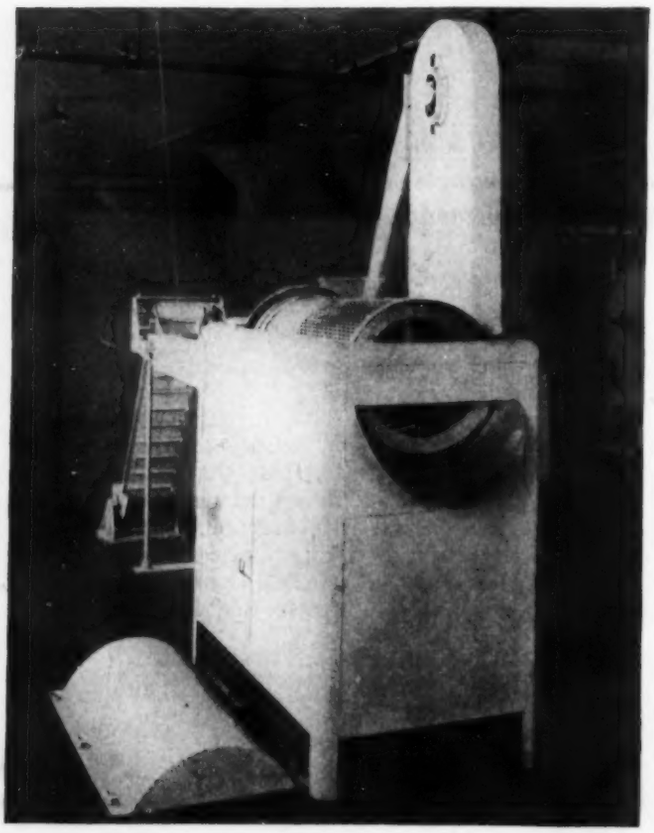


Fig. 3—The operating parts of the machine, consisting of a drum with a helical channel on the inner periphery, a bucket elevator feeding into the drum, and a hopper for feeding the elevator, as well as the casing itself, were redesigned for fabrication by welding

All vertical and horizontal members comprising the corner posts, top members and mullions, also bottom, top and side rails of doors, are stock, square-edged steel bar $\frac{3}{16}$ in. thick; all sheets comprising the panels are of No. 12 gage. The floor on which the drive unit is mounted is made up of $\frac{3}{16}$-in. steel sheet, with the front edge bent up at right angles to serve as the bottom door stop. The panels are tack-welded, from inside, to the corner members and to the mullions.

The drum, as shown in Fig. 3, is made of perforated steel with a longitudinal welded seam and the helical flight inside the drum is tack-welded in place. In fact, the only castings used in building the frame of the machine are the four spherical corners where the posts and top members meet. These are of $\frac{3}{16}$ in. thick cast steel, to avoid the forging otherwise required to produce the rounded effect.

The hopper, into which the elevator spout leads, is an aluminum casting, but the elevator housing and spout are of arc-welded steel. Ball bearings are used throughout, and the housings for these are of cast iron.

The driving mechanism is an independent unit, which can be completely assembled before being mounted in the frame. To overcome possible resonance from the box-like steel frame, a thin layer of soft packing was placed between the drive mechanism and the steel bottom-plate of the frame. The machine, when running with the doors closed, is practically noiseless.

The feed hopper, shown on the side of the frame in Fig. 3, is attached by capscrews, for convenient removal when packing the machine for shipment. The spout of the elevator is likewise bolted to the elevator leg for the same purpose, as well as for convenient removal to gain access to the top sprocket. The elevator leg is detachable from the frame, while, for reassembling and cleaning, a large access door has been provided in the elevator boot. The absence of guards and exposed mechanisms is of particular note in the new design, as compared with the original, while at the same time all parts are better protected and more readily accessible.

Aside from the very noticeable improvement in appearance made possible by redesigning for arc-welded fabrication, the adaptability of this type of construction makes it possible to change the design of the machine, if necessary, during the course of construction, at a small fraction of the additional cost involved had cast-iron construction been employed. Thus, constant improvements in the design of new machines can be made by the manufacturer without serious increase of production costs or loss of production time. This advantage of welded steel construction over the traditional cast construction is chiefly in the elimination of patterns.

Dimension Lines on Drawings

By Harry Hoisington
Ordnance Engineer, Rock Island Arsenal

THE remarks of L. O. Brown in the *American Machinist*, vol. 70, page 943, concerning dimensioning of drawings from one side and one end of the part, instead of invariably from a center line, are logical except that in many fixtures it might be better to dimension from contact points on the work. Particularly would this be preferable where tolerances in thousandths are involved.

Such tolerances should not be referred to imaginary lines when the critical measurements may be better expressed by reference to a contact point. For example, a dimension referring a key or keyway to a bracket ledge, instead of from the ledge to a center line of the key should be given from the ledge to the critical side of the key, or keyway; then neither the draftsmen, toolmaker, workman, nor inspector need make any computations for the effect of the tolerances. Where the pressure on a cylindrical bearing is always in one direction, it may be better to dimension from the bottom of the bearing instead of to the center.

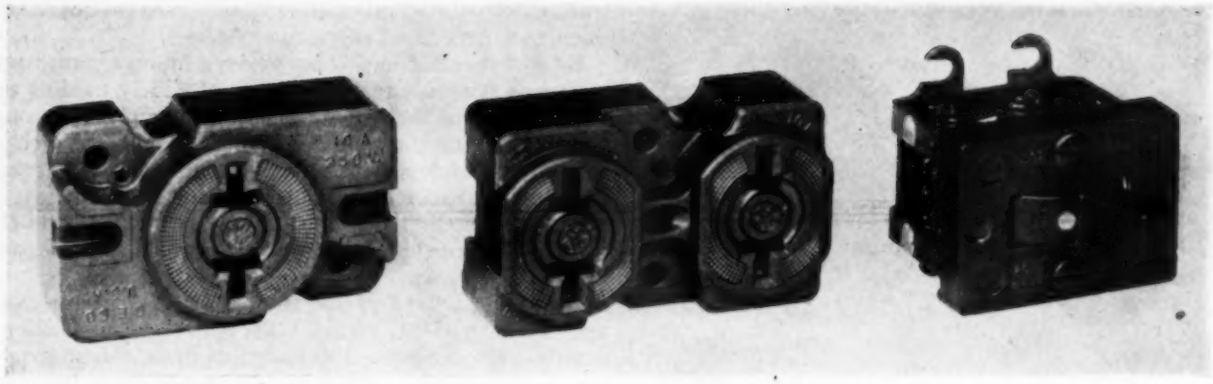


Fig. 1—The above objects, a base for a convenience outlet, a twin base for a convenience outlet, and a flexible tumbler switch, are typical of the many molded products designed and produced for electrical service

MOLDED PRODUCTS That Replace Metals

By H. D. RANDALL

Industrial Department, General Electric Company

THE use of molded plastics in the manufacture of industrial parts and products has expanded to a most marked extent. In five years, from 1923 to 1928, the quantity of synthetic resins used in making parts produced by the hot-molding process at the Pittsfield Works of the General Electric Company increased more than one-hundredfold. Over 2,000,000 radio tube bases and accessories, and half that number of industrial products, such as controller and magnetic switch panels and parts, plugs and sockets, spools, distributor caps, clock cases and similar items, are made each week, as Textolite products, at the Pittsfield Works. Some are for the company's own use, but the majority are for the trade. This output of around 160,000,000 pieces per year, the largest production molding job in the world, does not include the items produced at other General Electric plants—Textolite gears, gear blanks, and gear board at Lynn, and laminated sheets, tubes, rods and the hot-molded and cold-molded industrial products at Schenectady.

The art of molding plastics is not new, dating back to the time when rubber, celluloid, shellac, and other plastics were applied commercially for the production of molded parts for industrial purposes. Consequently, the problems of design are fairly well understood. But the advent of many new plastic compounds, and the vastly widened field of application, leading to mass production with its demands for low cost, have given these problems of design paramount importance.

Molded plastics offer design problems quite different from metals. This article discusses the properties of the materials used, and the applications for which these materials are suitable. Succeeding articles will outline elements of design which avoid manufacturing difficulties and result in a durable, serviceable, well-finished, economical product

The question of materials is the first consideration in connection with design. Molded products are compounded from two general classes of raw materials—binders and fillers. The binders render the mass plastic and give it coherence, mechanical strength, chemical stability and insulation value. Fillers are finely divided materials used to decrease shrinkage, cracking and variation in dimensions, to increase mechanical strength and toughness, and to lower cost. They also prevent the material from adhering to the mold. Certain fillers are superior to others from the standpoint of mechanical strength, higher insulation value, greater heat resistance, better colors, less wear on molds, and other factors. A full discussion of this subject is given in an article on "Molded Insulation," by Lawrence E. Barringer, in the *General Electric Review* of August, 1927.

The first of a series of articles on molded products. The next will appear in an early issue.

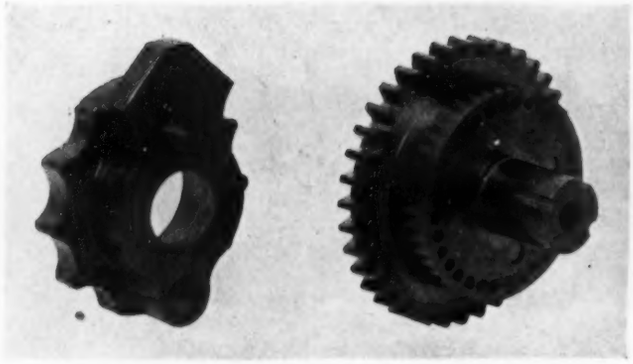


Fig. 2—The accuracy obtainable in molding is demonstrated by this adjuster and gear for a window-opening limit switch. Parts like these require no finishing

The following binders are used in making molded articles: Synthetic resins, natural resins and gums, asphalts, pitches, drying oils, rubber, and silicate cements or compounds (waterglass, Portland cement, calcium silicate, and similar products). Celluloid, casein and blood albumen have also been employed, but are not suitable for electrical equipment because they are low in heat resistance, and are not altogether moisture-proof.

Some binders merely fuse the particles together, others undergo a chemical reaction and permanently bond them. Of the former type are shellac and, less rarely used, copal, Kauri, ordinary resin, and Dammar. These binders cause the compounds to make up into products with a good finish, having comparatively high mechanical strength, good insulating properties, and resistance to moisture, but which soften at moderate temperatures, which in the case of shellac is approximately 70 deg. Centigrade.

For cheaper grades of products, asphaltic binders are also used. Their cost is low, and due to a distillation of volatile constituents during the processing, the heat resistance of the products is raised to around 100 deg. Centigrade.

Other binders and their fields of application are: Rubber, for molded flexible articles such as bushings, gaskets and diaphragms; drying oils and pitches, molded at room temperatures, baked in electric ovens to bring about chemical changes converting the products to a permanent form, and used for color effects in wiring device parts; lead borate, used with ground mica to form "Mycalex," which has high heat resistance, high dielectric strength, high mechanical strength and low power losses under high frequency, making it especially suitable for radio equipment; inorganic binders, such as water-glass or a hydrous calcium silicate, each of these being mixed with asbestos and other fillers, and used to make arc shields, or deflectors, and similar devices.

By far the most important binders, however, are those known as synthetic resins. The most widely used of the synthetic resin binders are those of the phenol group. Bakelite was the first successful compound of this character to be developed. The bonding action is due in part to fusion, but more especially to chemical change. It is brought about by the action of heat, which converts the resin from a fusible and soluble form to an infusible and insoluble form.

Some of the binders are formed from glycerine bases and are termed "Glyptal." They have been combined mainly with inorganic fillers such as mica, asbestos, talc, and similar substances, and have high resistance to arcing and carbonization, are mechanically tough, and are free from odor. To a limited extent they have also been used with organic fillers.

Fillers for molded plastics play no part in the chemical reaction, and are added merely to impart desired physical properties, and to reduce the cost. Both organic and inorganic types are employed, all finely divided and chemically stable. Wood flour, cotton flock, silex, mica, asbestos and slate and marble flour are commonly used, on account of their commercial availability.

Wood flour is porous, provides a good cling between binder and filler, gives a close grain, imparts a high mechanical strength, takes a high finish from the smooth steel mold, and has only a slight abrasive action on the mold. Its main disadvantages are the difficulty of keeping it perfectly dry, so that the molded product will have a high dielectric strength, and its low heat resistance compared to mineral fillers, which prevents its use with inorganic binders of the silicate type for arc-resisting applications.

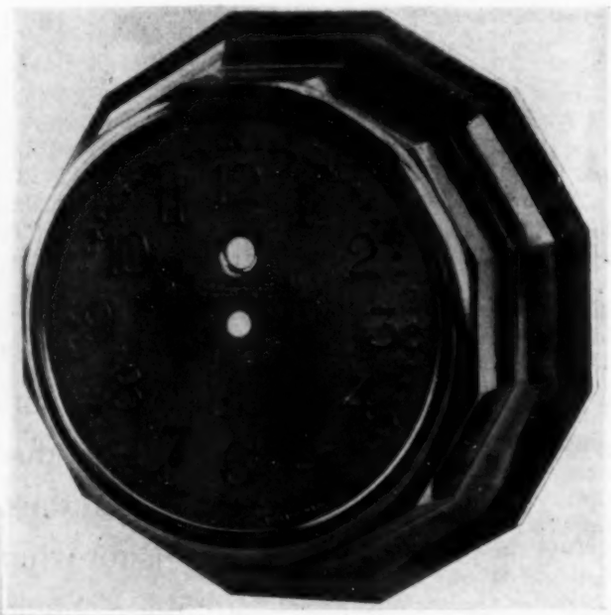


Fig. 4—The Telechron clock face shows the close limits and high finish obtainable in a good mold

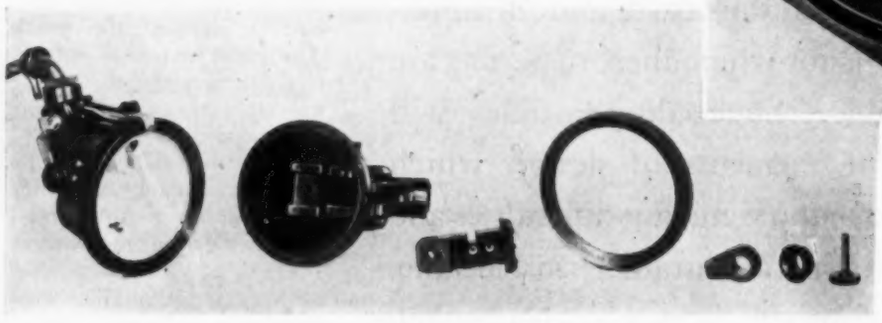


Fig. 3—The Edison Storage Battery miners' lamp illustrates the high quality of molded products

Asbestos filler has high heat resistance, and fair mechanical strength, but gives a dull and uneven surface appearance because of the long fibers, and often is low in dielectric strength because of the presence of metallic iron. Mica filler has excellent heat resisting and dielectric properties. Cotton flock, or ground cloth, or canvas, is used as a filler where toughness is required.

Molding of binder and filler materials is done by one of two processes—hot, or cold. Hot molding consists of making the mixture plastic by heat, either before or after placing in the mold, compressing it to shape, holding it under pressure, until a permanent set is produced, and then removing it, either hot, or after a short cooling period. The binders employed are organic materials, principally synthetic resins. Fillers are: Wood flour for high finish and light weight; mica for heat and electrical resistance; asbestos for heat resistance; and cotton flock for mechanical toughness.

The properties possessed by products made by the hot-molded process are:

1. Accurate conformity to mold dimensions.
2. High mechanical strength.
3. High dielectric strength.
4. Good finish and smooth, polished surface.
5. Resistance to water and most chemicals.
6. Only slight abrasive action on molds.

The disadvantages characterizing the products made by this process are:

1. Softening, or carbonizing at high temperatures.
2. Non-resistant to electric arcs.
3. Expensive molds.

Cold molding is done at ordinary temperatures, the compound being rendered plastic by water, some organic solvent, or a vegetable oil. After being formed in the mold under pressure, but without heat, and having the flashings removed, the products are baked, or treated with steam, to harden them. This process is one of distillation. Some chemical action occurs, converting the parts to stonelike masses. Occasionally, oxidizing oils are used to assist in the hardening action.

Electric ovens are used at the General Electric plant for the baking process. The products are maintained at even temperatures for three ranges of time, to avoid the formation of a crust on them, and to prevent the generation of internal gases faster than they can be carried to and off of the surface. The parts are baked for periods varying from 24 hours to one week.

Products made by the cold-molded process possess the following advantages:

1. Higher resistance to heat and arcs because of inorganic ingredients.
2. Low cost, because molds are cheap; fewer molds are needed, since no time is consumed in curing the products; and molds and presses are not heated, and steam connections are not required on the presses.

The disadvantages possessed by products made by the cold-molded process are:

1. Low mechanical strength.
2. Low dielectric strength.
3. Lack of a good finish.
4. Greater abrasive action on molds.
5. Greater variation from given dimensions, as products harden out of molds and are free from restraint.

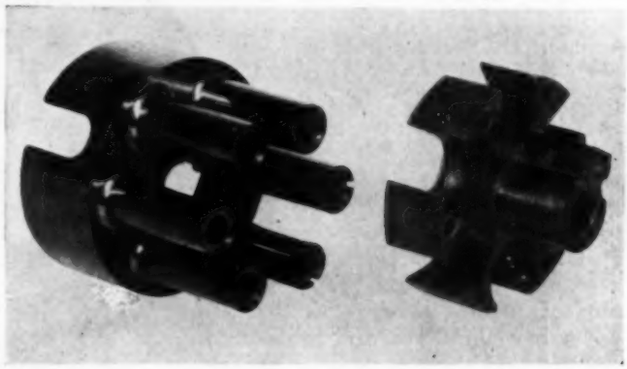


Fig. 5—This contact-rod support and head for a plunger-type ratio adjuster illustrate the possibility of obtaining long and somewhat thin sections in molded products

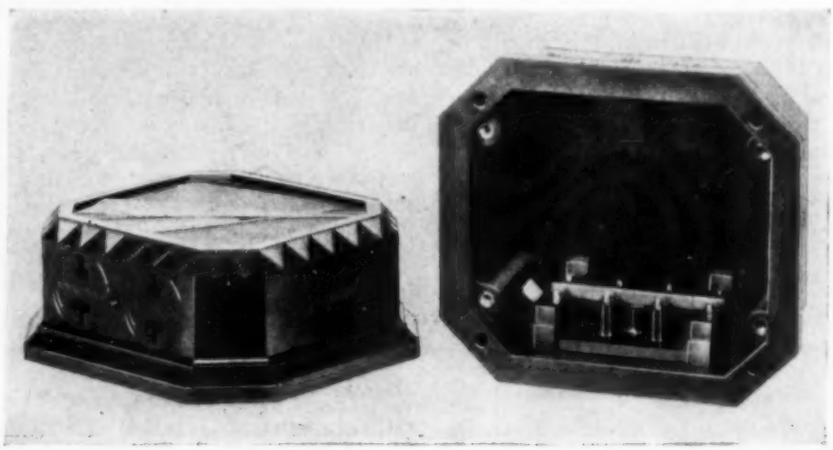


Fig. 6—The Edison Electric Appliance Company table timer box and outlet block is another example of a beautiful and serviceable molded product. It is made in color

6. Thin, flat pieces are difficult to produce.
7. Large pieces are more difficult to make than by the hot-molding process.
8. Parts are more difficult to machine than hot-molded products. Drills are dulled by the abrasive filler and lubricating binder. Tapping is not successfully done. Metal inserts are preferable. The products can be ground to size, however, and buffed for finish.
9. Colors of products are limited largely to black or brown. Lighter colors darken with age.

Whether or not cold-molded products are impervious to moisture, depends on the compound. Porous types can be treated with waterproofing compounds.

The quality of the finished molded plastic product depends upon the care used in selecting materials and in the manufacturing processes. In order to insure uniformity of properties, many of the ingredients are first subjected to special treatment. For example, the wood flour is thoroughly dried before mixing with the powdered resin. After incorporating with the resin, the mixture is stored in sealed containers or heated ovens so as to eliminate all traces of moisture, the presence of which in the finished article would tend to reduce the electrical strength.

The removal of foreign matter, such as iron, from

materials like asbestos fiber and powdered mica, is, of course, essential. To produce a uniform material, especially as regards mechanical strength, the proper length of fiber, or in the case of mica, the proper grain size, is carefully maintained. Synthetic resins that have been overheated in their preparation have too high a fusibility and should not be used. Exact proportions of ingredients are required. Temperature, pressure, and time of molding should all be controlled, the temperatures by steam gages or thermometers, and the time by some signalling device. If these precautions are not observed the products may lack uniformity and be unsuitable for the service which is required of them.

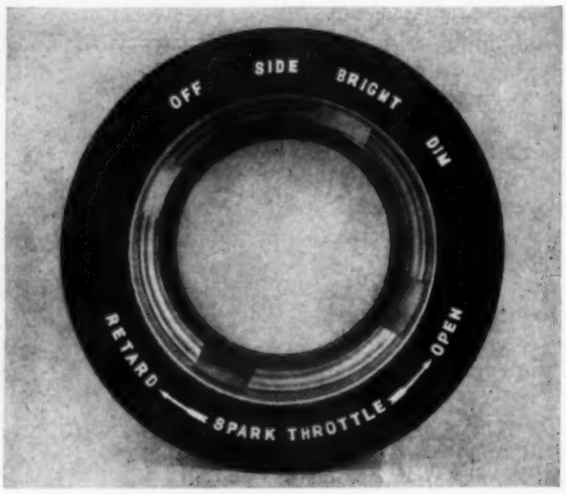


Fig. 7—The Hudson Motor Car steering-wheel cap is made of molded insulation. The letters are depressions filled with enamel

The designer and user are called upon to familiarize themselves with the general properties of molded products to ascertain where they can be employed and the correct way to apply them. All such compounds, except soft rubber, lack flexibility and elasticity. They will not withstand severe shocks, because of rigidity and brittleness, and should be protected against such injuries when equipment is designed which makes use of the molded products. They are, however, tougher than many other insulating materials, and hence are suitable for a wider service.

Molded products have not the unit strength of metals under tension, compression and shear, but, if dimensions are increased sufficiently to provide the same total strength, they can be employed to replace metal parts in many instances. Hot-molded products, especially shellac and the synthetic resins, will not resist high temperatures, under which they soften, melt, or carbonize. Shellac distorts at 55 deg. C., phenolic resin compounds at 135 deg. C., and hot-molded asphaltic-base compounds at 200 deg. C. But cold-molded lime silicate is good up to 700 deg. C., and will not be destroyed up to about 1,300 deg. C., below which copper will melt. Hence this material can be used under all temperatures to which electrical apparatus is subjected under the action of an arc.

Molded products, in general, are chemically stable and resist attack by water, acids, alkalies and solvents used in varnishing and finishing compounds. From the standpoint of insulation, the porous, refractory types are low in value, while the synthetic resin compounds, with suitable fillers, are high. The same is true of volume resistivity and dielectric losses. Surface resistivity is high on most of the molded products, if their surfaces are clean. Most of the molded materials, except asbestos lime-silicate and similar compounds, will break down under arcing, and many of them, especially the phenol-resins, will carbonize and pit. Glyptal offers more resistance, while hard rubber is, in this one respect, a far superior compound.

Molded products lend themselves readily to the pro-

Table 1. Physical and Dielectric Properties of Molded Plastic Products

Type	Surface	Water Absorption (Per Cent) (24 Hr. at 21 Deg. C.)	Heat Resistance (Approximate Temperature Deg. C Up to Which Not Affected)	Compressive Strength (Lb. per Sq.In.) (1" Cube Specimen)	Transverse Strength (Modulus of Rupture) (2.875" by 1.5" by 0.375" Specimen)	Impact Resistance (Charpy Machine) (Ft.-Lb.) (0.5" by 0.5" Specimen Section)	Breakdown Voltage (Kv.; 0.2" Thickness)	Power-Factor and Dielectric Constant 10^6 Cycles, 25 Deg. C. PF.%	K	Relative Cost A = Lowest E = Highest
Cold Molded Organic Binder (Pitch and Oil)	Hard Smooth Impervious	1.0 to 2.0	250	8,000	3,500	0.35	10	...	...	B
Cold Molded Inorganic Binder (Calcium Silicate)	Hard Porous	10 to 15	700	14,000	3,500	0.30	Variable Low	...	...	A
Cold Molded Inorganic Binder (Calcium Silicate) (Water proofed)	Impervious	Less than 0.50	150	14,000	5,200	....	13	...	...	B
Hot Molded Organic Binder (Shellac)	Hard Smooth Impervious	Less than 0.25	55*	7,000	3,000	0.20	40	...	...	C
Hot Molded Organic Binder (Phenolic Resin)	Very Hard Very Smooth Impervious	Less than 0.25	135*	19,000	10,000	0.70	50	3	5.8	D
Hot Molded Inorganic Binder (Lead Borate)	Very Hard Slightly Rough and Slightly Porous	Less than 0.50	300	22,000	17,000	0.45	65	0.5	9.2	E

*Distortion point.

duction of varied and beautiful color effects. Stop buttons are regularly produced in two colors. Ten-color products have been successfully made. Glyptal can be produced in transparent, single-color effects as clear as glass or crystal, for use in mechanical pencils and similar products.

Table 1 lists the important properties of the principal types of molded materials.

Testing of molded products, and the development of adequate, acceptable standard means of testing, are of prime importance to the designer, who thereby is enabled to make suitable comparisons and intelligent use of such products, with confidence in their applicability and service qualities. Practically all factors involved in testing, especially for electrical work—thickness of specimen,

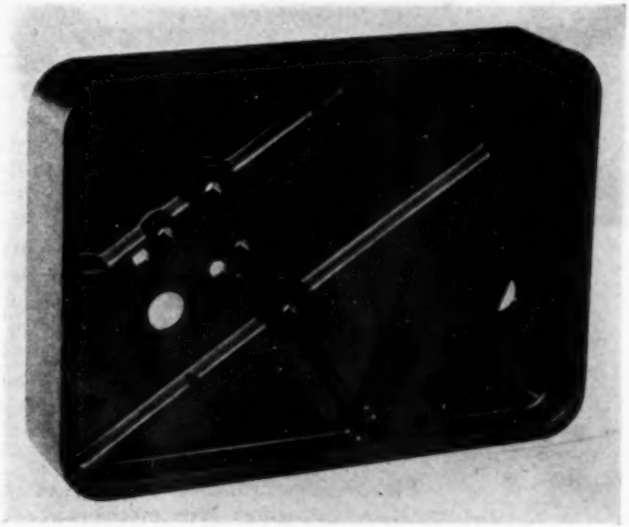


Fig. 8—Large flat objects such as this base for a reverse-phase relay are successfully produced by molding

its temperature, humidity and temperature of surrounding air, the size, shape, pressure and material of the electrodes, voltage frequency, rate of voltage application—affect both insulating properties and physical characteristics of the products. The designer is interested in knowing these relative properties of the various molded products and their comparison with properties of the metals with which they are to be used, or which they replace.

On the other hand, it must be recognized that in molded materials it is not possible to obtain absolute uniformity of composition in the cross-section of any one specimen, nor this uniformity between specimens, that can be obtained in metals. Hence, when values are obtained by testing standard specimens, these values may not always apply exactly to all shapes and sizes of the same kind of materials.

However, it is important for the designing engineer to become familiar with the relative characteristics of molded materials, and to know that one material may be 25 or 50 per cent stronger than another, or that it may have considerably higher or lower dielectric strength. In electrical design, it is necessary to know the general relationship between the physical and dielectric properties of the metals employed and the molded materials that are made into products to go into the same apparatus. When the values for molded insulation, derived from standard tests, are used in this way, they form valuable information for the designer who intends to develop molded products for the equipment he plans to make.

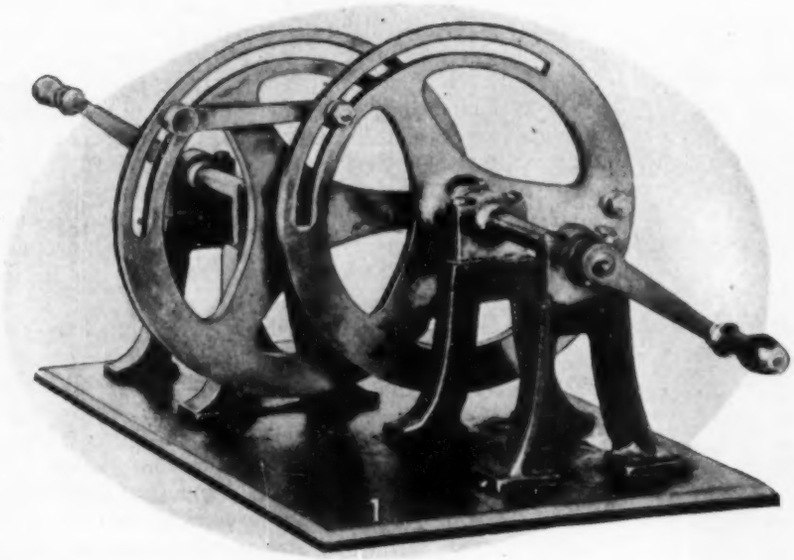
General Electric Company engineers, in conjunction with the American Society for Testing Materials, American Institute of Electrical Engineers, American Ceramic Society, and other associations, have developed standard test methods for insulating materials. The General Electric Company has over 80 such methods for use at the present time. The tests which apply to molded insulation have been published by the American Society for Testing Materials in "Standard Methods of Testing Molded Insulating Materials, Serial Designation D48-27." For comparable and satisfactory results, the methods established for these tests should be followed by designers who wish to conduct investigations on molded products in their own plant laboratories, or to have the studies made by commercial laboratories.

In most cases, molded products are applied as substitutes for similar parts of metal, or other materials. The object in making the substitution may be to secure some properties in the finished article which these other materials do not provide, but usually it is to reduce manufacturing cost. The previous design may have involved a complicated and expensive building-up procedure, as with parts for electrical service made by combinations of metal and insulating materials, or it may have required a number of machining operations. The molded plastic product often does away with most of the assembly work by providing, in one operation, an insulated piece to which metal parts can be directly attached. It frequently eliminates machining entirely

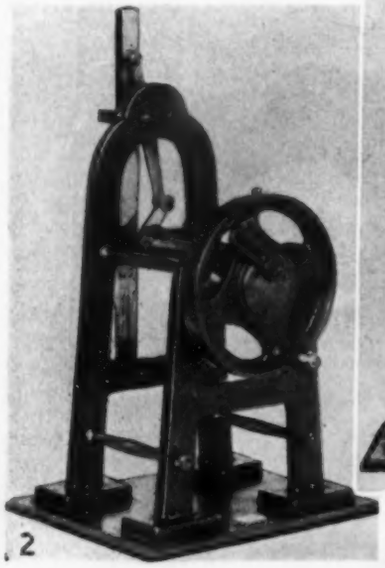
Fig. 9—Careful design makes possible the production of irregular objects such as this circuit-breaker handle

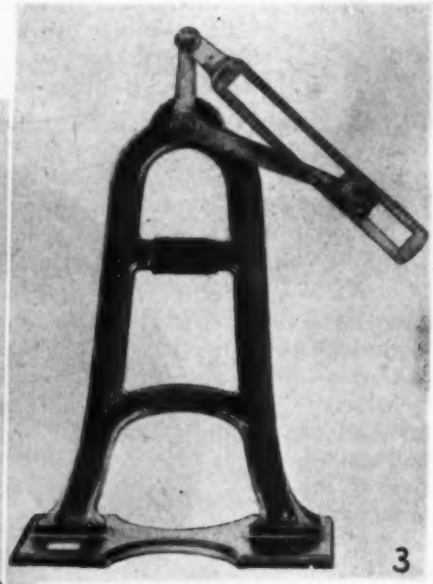
by coming from the mold in completed form with all surfaces, holes and projections accurate in size and shape. The cost is usually far less, and the product is often considerably improved over the former design. Not only may it be shaped as desired, containing holes, screw threads, figures, letters and designs, but also it may possess a high surface lustre requiring little or no finishing treatment. It is evident, therefore, that every designing engineer has a definite responsibility before him in applying molded compounds to his products, because of the economies he may secure.

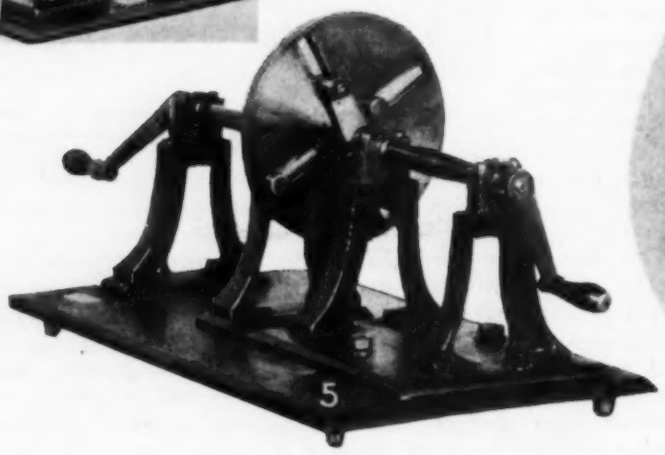
Some Mechanical Motions



Photographs by courtesy of the Museums of the Peaceful Arts, New York. Model are the property of the Sheffield Scientific School, Yale University, New Haven







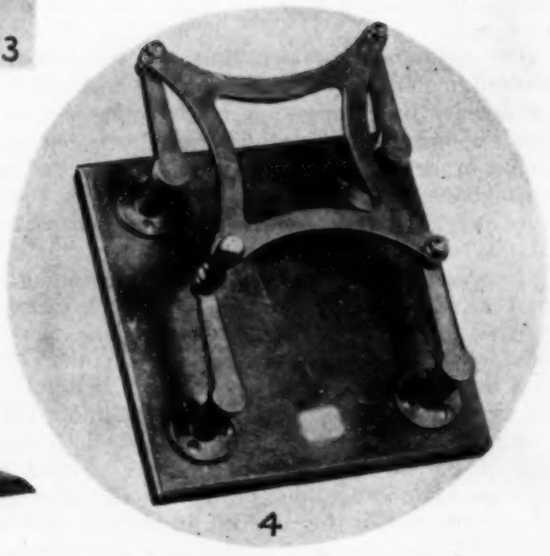


Fig. 1 — Parallel-link motion used to connect locomotive driving wheels. In actual application the links are on opposite sides of the engine

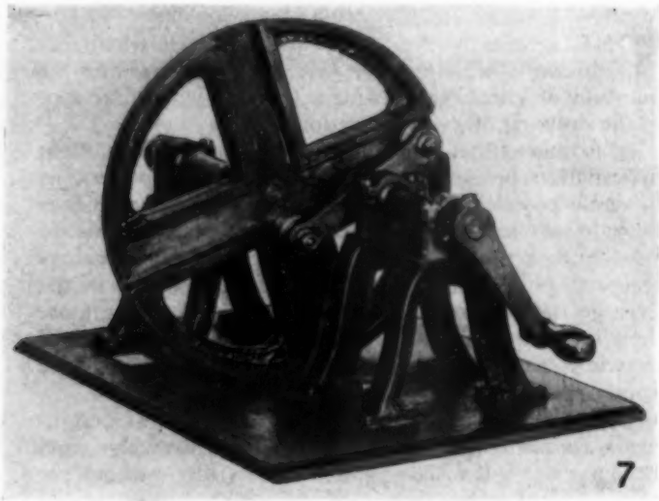
Fig. 2 — An application of the Whitworth quick-return mechanism. The slotted crank shown in the foreground is driven by the pin in the face of the flywheel. The crankshaft is offset in the large flywheel journal

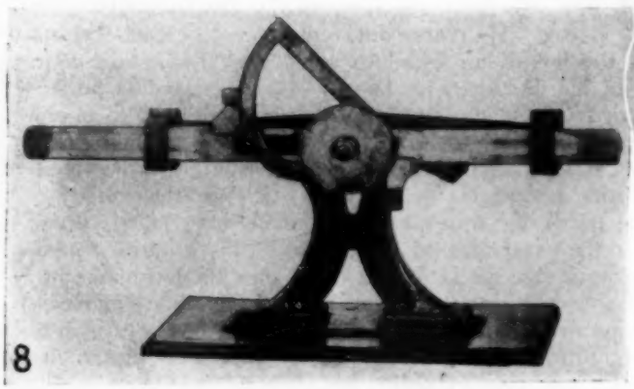
Fig. 3—This device produces irregular rotation from regular motion. The slotted connecting rod rotates about its fixed pivot point at the upper end

Fig. 4—A symmetrically-shaped member with four pivot corners makes the four cranks turn at once

Fig. 5—Illustrating the principle of the Oldham coupling. The mechanism consists of a disk with four equiangular slots engaging crossed slider cranks on the driving and driven shafts

Useful in Machine Design





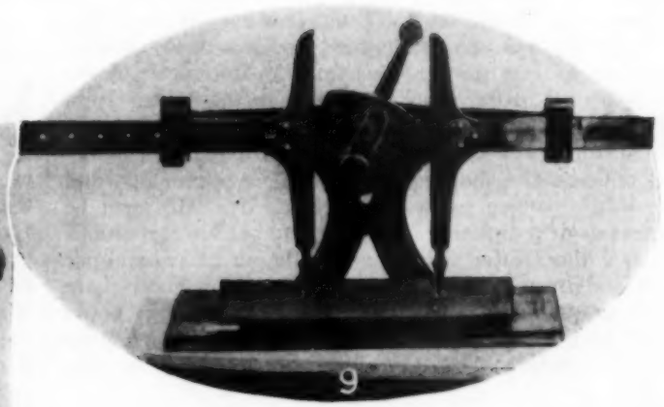


Fig. 6—A modification of the worm and wheel is found in this one-tooth pinion, and 50-tooth gear mechanism that gives constant or intermittent motion

Fig. 7—A modification of the mechanism shown in Fig. 5. The shaft carrying the crossed slider cranks is located at the half radius of the grooved disk, giving a uniform velocity ratio of 2:1

Fig. 8—An involute cam arranged to give uniform reciprocating motion through upper and lower contact members. Thrust is always in the direction of motion

Fig. 9—This three-leaf cam with parallel cross-slides gives three cross-rod reciprocations per revolution with the driving pin as shown. Only one reciprocation is obtained with the pin at the opposite end of the slot

Fig. 10—In this mechanism, a planetary spur gear runs around four concentric gears, the two outside equal ones being fixed, and the two inner ones having one tooth less and one tooth more, respectively. When the planet arm is revolved, one inner gear moves slowly forward, the other backward

A Method for Checking Drawings—*Discussion*

By J. H. Groom
Chief Draftsman, Cincinnati Grinders Incorporated

THE articles in the *American Machinist* which began with the one on p. 251, Vol. 70, regarding the question of checking drawings, touch a very vital spot in the drawing office organization of today.

It is more than ever necessary that drawing room information be sent to the works as near perfect as humanly possible, in spite of the terrific pressure that is brought to bear on most engineering departments to get the work done. Checking or inspecting all drawings seems to be the best way of accomplishing this in the average drawing office that has on its staff 25 or more men of various grades, and where the details or final drawings are made by the less experienced men and youths who are in training.

There are some draftsmen who are capable of designing a complete machine, making all the drawings, and carrying the job to completion successfully without the aid of a checker, but these men are none too plentiful and can generally be used to much better advantage as designers, leaving the detail work to less qualified men.

Great care should be exercised, however, in the selection of a checker. A really good one is a most valuable asset to any engineering department. It is perhaps the wisest course to train picked men from the organization for checkers rather than to hire outsiders for the job. A man thus trained should know the company's product and policies, the shop equipment and requirements, and the drawing office routine and standards. He must be somewhat of a diplomat and be able to get his corrections across without offense. Above all, he must have and use good judgment. If he does not possess a good share of these qualifications he may become a sort of "bottle neck" to the department and choke off the best efforts that are made to bring the work to a successful conclusion.

There should be a great deal of difference between checking drawings that are for production work which will be duplicated many times and special jobs that are to be made once only. In the former case, great care must be taken to have the drawings perfect as far as dimensions are concerned. Also it must be seen that everything possible has been done to make clear to the shop and production department just what is required in the way of tolerances, classes of finish, and relations of surfaces such as permissible out-of-parallelism or out-of-squareness. The drawings should also conform exactly to the standard for drawings as adopted by the company. In some of the larger companies this becomes a task in itself and is assigned to a special checker. The method of making the part should be studied carefully and consultations held with the production department and shop regarding methods of manufacture when necessary changes are made to facilitate production before the parts ever reach the shop.

In the latter case, if a drawing is correctly dimensioned, and is reasonably within the prescribed standards, it is a waste of time to check and correct the drawing for all the points mentioned in the former case. This seems to be partly obvious, but it is sometimes difficult to get checkers to appreciate it.

Another item that needs careful checking is the list of parts or bill of materials that is sent to the shop from the drawing office. An error on these lists can be quite as serious as one on a drawing. The manner in which they are written and the exact form that they take are often of great importance in order that the information contained may not be subject to misinterpretation by the people for whom it is intended who must act upon the information given. If this item cannot be supervised personally by the chief draftsman, he should designate some one to look after it who is familiar with the shop and production routine.

It becomes apparent that the checker develops into an important personage, and if he has executive ability he may later provide material for a more responsible position.

Give the Draftsman a Chance
Discussion

By W. R. Needham,
Engineer, Design Department, English Electric Company, Ltd.

KARL NIXON on page 698, Vol. 70, of the *American Machinist*, pleads that the draftsman be given his chance. He points out, quite correctly, that the man at the board has often to stand the "racket" of more than his due share of blame. However, unless he suffers from an excessive "inferiority complex," it is generally possible for him to clear himself where he is not at fault. The chief, or section chief, who habitually works against his men seldom sticks in the employ of the particular company. The main thing is, of course, for the draftsman to make sure of his ground, frankly acknowledge his faults, let those slips he does make lead him to do better work, and where he is not to blame, to stand firm against unjust accusation. Moreover, in clearing himself, he need not fix the blame on someone else.

In one case in point, an assistant was sure of his ground in certain involved calculations. The works manager disagreed. The assistant respectfully held to his conviction, offering to put through instructions to the manager's recommendations, but declining to accept responsibility. The manager, essentially a fair-minded man, thereupon referred the matter to the chief designer. The latter at first agreed with the manager. Still the assistant held to his guns, so sure was he that he was right. The chief designer then decided to study the matter further. Within two days the manager came to the assistant and acknowledged that the latter had won his point. Thereafter, the assistant, who until that time had been accounted merely as a reliable man, was frequently brought into consultation by the manager when matters of technical importance were at issue.

It is a great mistake, however, for the executives of any organization to insist that highly involved work shall be produced in record time—a race against the clock. A mistake—excusable if ever there is excuse—under such circumstances may involve delay, high cost, and considerable friction between departments.

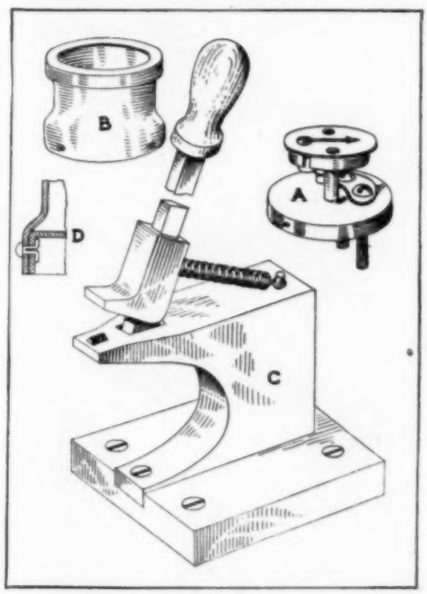
IDEAS FROM PRACTICAL MEN

The department, "IDEAS FROM PRACTICAL MEN," is devoted to the exchange of information on methods useful to the machinery industries. It includes all divisions of engineering practice, from design problems to engineering equipment. Descriptions of methods or devices that have proved their value are carefully considered, and those published are paid for. The rates are from a minimum of five dollars upwards, depending upon their merit.

Rivets Versus Screws

By CHARLES H. WILLEY
Asst. Plant Supt., Hoyt Electrical Works

In certain types of electrical instruments, the movements are mounted on metal bases, as at *A*, and are inclosed in cases such as the one shown at *B*. For many years, the cases were secured to the bases by small screws, involving the tapping of three holes in the flange of each base. The metal to be tapped being but $\frac{1}{32}$ in. thick, was never very satisfactory for the operation and we often found that the threads were stripped in many of the holes. By fastening the cases to the bases with small split rivets instead of screws, the cost has been reduced from $1.25 to 40 cents per hundred instruments. Another advantage in using rivets is that they make the instruments more nearly foolproof, because a user will hesitate to extract rivets when he might take out screws.



Method of sealing instruments with split rivets

The operation of fastening on the cases consists in putting the rivets in the holes, placing the bases of the instruments over the anvil of the fixture *C* and pulling the lever. The rivets are spread, as shown at *D* above.

A Blackboard in the Drafting Room

By ROY E. PETERSON

In our drafting room is a slate blackboard of the usual schoolroom type, with a shelf at the bottom for chalk and erasers. The board extends the full length of the room. It is about 4 ft. high, and the lower edge is 3 ft. from the floor. The entire surface of the board is divided into 2-in. squares outlined in fine red lines. On this board we make full size preliminary layouts, and sometimes to even larger scale, and working at the blackboard provides the draftsman or designer with a welcome change from the uncomfortable position necessary at the drawing board.

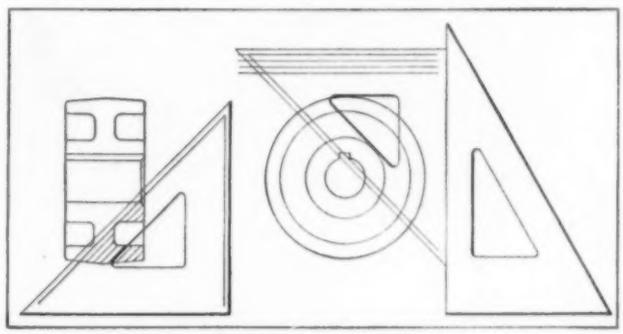
It is difficult to discuss mechanical design without making sketches, so when a conference or discussion is to be held it is usually done at the blackboard. At times it is desired to explain some principle of design to the drafting room apprentices and the blackboard affords an easy method of doing this.

A Method of Cross Sectioning

By L. COON
Kellogg Manufacturing Company

In making mechanical drawings, type lettering and the cross sectioning of cutaway views are necessary. If the letters of the title are of the same height and inclination, and the cross sectioning is evenly spaced, it adds much to the appearance of the drawings. If the work can also be done quicker, it decreases the cost as well.

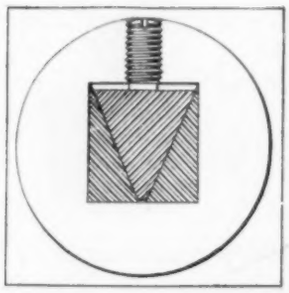
A simple method of doing this kind of work is to score a line near the edge of a 45-deg. celluloid angle, corresponding to the standard length of the title space, and one quarter of the height that is used for type lettering. On the long edge of the angle a similar line is scored for cross sectioning, as shown in the illustration. In using this method the celluloid angle is moved in a direction the reverse from the usual, in order that the scored line may coincide with the line drawn previously. It is apparent that this method can be used only for pencil work on the original drawings, as the wet ink will run under the angle.


Drawing uniformly spaced lines with a celluloid angle

A Three-Piece Wedging Key

By I. B. RICH

In repairing an old door lock, some time ago, I found that the knob-spindle was made in an unusual manner. Instead of being a piece of square, commercial steel, it was made in three pieces, two of which were wedge shaped on one side only, while the third piece was wedge shaped on both sides. The pieces that had been so



A key that always fits the keyway and can be tightened

shaped on one side only were at the outside, while the piece that was wedge shaped on both sides was placed between them, as shown in the illustration.

The small setscrews in the hubs of the knobs bore on the central, or V-shaped piece. When the screws were tightened, they forced the central piece down, pushing the side pieces out into contact with the sides of square holes in the knobs, thus holding the knobs tightly.

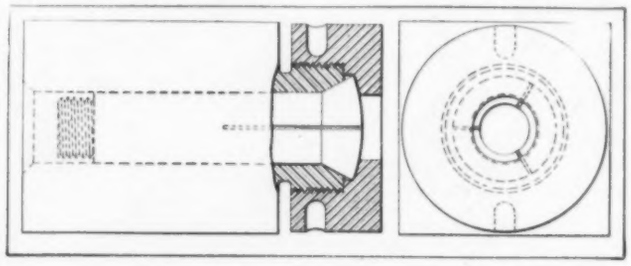
Why is not this same construction applicable to keys where it is essential that they fit tightly on the sides of the keyways? Of course, it would not always be possible to use setscrews for tightening the central member, but its shape would make it ideal for a driven key, either from the end or as a blind key.

A Holder for Collets

By Theodore Kruger

We often have use for collets for holding drill rod and other round material in our milling machine and our grinder. Since we have a full set of collets belonging to the bench lathe in our toolroom, I decided to make a holder for them so that they could be used in other machines.

The body of the holder is made of tool steel. After being hardened, it was ground accurately square so that



A collet holder

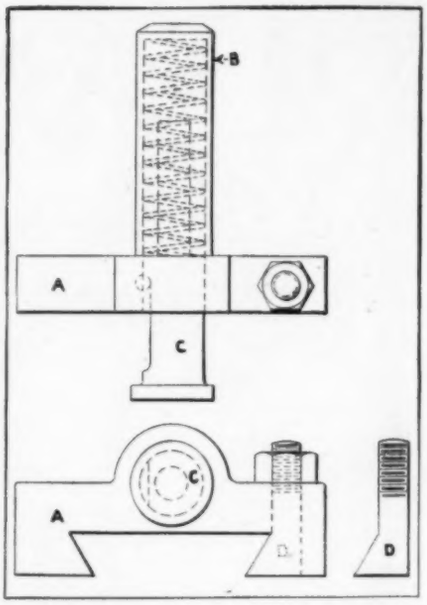
it could be held in the vises of the milling machine and the grinder. It can easily be held in the spindles of any of our lathes, or other machines, by means of a four-jawed chuck. The cap is operated by a pin wrench. As it is screwed up the ledge at the front face forces the collet into the tapered nose of the holder and closes it on the work. When the cap is unscrewed, the natural spring of the collet, acting on the tapered nose of the holder, is sufficient to open it and release the work.

Precision Attachment for Lathes

By Otto A. Wagner

Every mechanic is familiar with the trouble caused by the "digging in" of a lathe tool, due to play in the feed screw. To eliminate this I have designed the fixture shown in the illustration.

The device consists of the body *A* which is machined to fit the ways of the cross-slide, or toolblock, and is held in place by the clamping bolt *D*. The barrel *B* is brazed to the body *A*, and contains a plunger *C*, and a stiff coil spring, against which the plunger acts. In use, the attachment is clamped to the cross-slide ways with the plunger head bearing aginst the tool block. Feeding the tool in compresses the spring, and takes up all lost motion in the cross-feed screw. This prevents the tool from "digging in" too deeply when the machining is done.



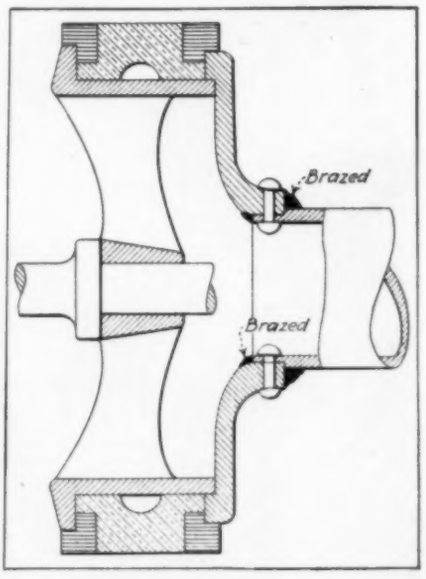
A lost motion take-up for the cross slide

Used in connection with a tool-post grinder it dampens the vibration of the tool block, and in general makes the cross feed much more sensitive.

Lightening Piston Valves

By W. P. Lambert

On a well-known railroad operating a number of three-cylinder locomotives, considerable trouble was experienced due to the valves being too heavy and not properly designed. Also, the motion work was not suitable for the operation of the valves on locomotives of this type. The valves were double ported, and the spools were cast in one piece. The bull and packing rings, however, were of the usual types. New spools were made by riveting and brazing light, cast-steel heads to the ends of sections of superheater flues, as shown in the illustration. Valves having spools of this construction are giving very satisfactory service. There is much less friction on the valve-chest bushings because the built-up spools weigh at least 150 lb. less than the ones they replaced in the chest.



Built-up spool for a piston valve

In making the change from solid to built-up spools, the valves were altered from the double ported to the usual single-ported type.

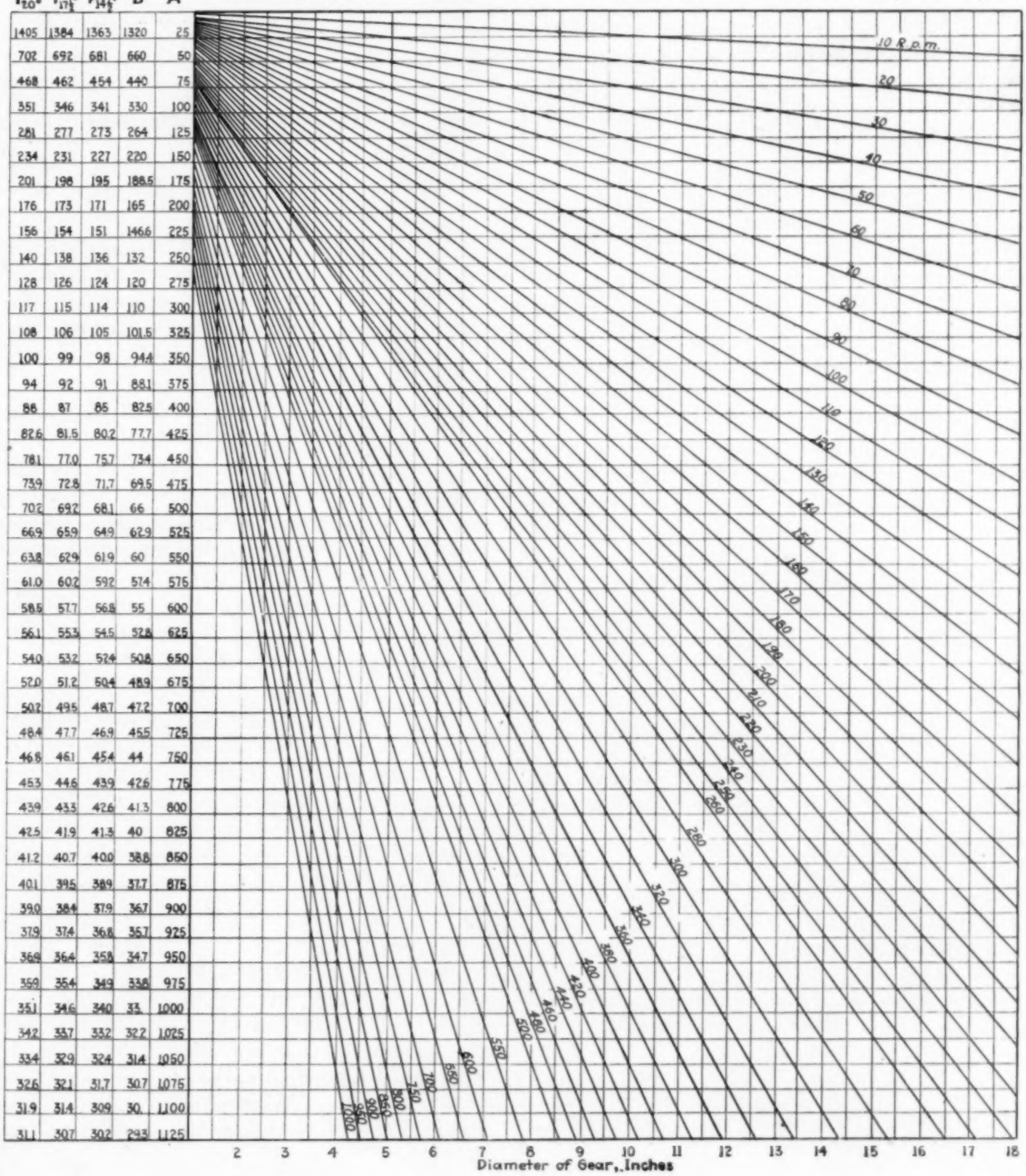
Bevel Gear Charts

Transmitted and Tooth Loads per Horsepower

Continued from Sheet No. 27

A = Pitch line velocity in ft per min. B = Transmitted load in lb. P = Resultant tooth load in lb. for various tooth pressure angles

$P_{20°}$	$P_{17\frac{1}{2}°}$	$P_{14\frac{1}{2}°}$	B	A
1405	1384	1363	1320	25
702	692	681	660	50
468	462	454	440	75
351	346	341	330	100
281	277	273	264	125
234	231	227	220	150
201	198	195	188.5	175
176	173	171	165	200
156	154	151	146.6	225
140	138	136	132	250
128	126	124	120	275
117	115	114	110	300
108	106	105	101.5	325
100	99	98	94.4	350
94	92	91	88.1	375
88	87	85	82.5	400
82.6	81.5	80.2	77.7	425
78.1	77.0	75.7	73.4	450
73.9	72.8	71.7	69.5	475
70.2	69.2	68.1	66	500
66.9	65.9	64.9	62.9	525
63.8	62.9	61.9	60	550
61.0	60.2	59.2	57.4	575
58.5	57.7	56.8	55	600
56.1	55.3	54.5	52.8	625
54.0	53.2	52.4	50.8	650
52.0	51.2	50.4	48.9	675
50.2	49.5	48.7	47.2	700
48.4	47.7	46.9	45.5	725
46.8	46.1	45.4	44	750
45.3	44.6	43.9	42.6	775
43.9	43.3	42.6	41.3	800
42.5	41.9	41.3	40	825
41.2	40.7	40.0	38.8	850
40.1	39.5	38.9	37.7	875
39.0	38.4	37.9	36.7	900
37.9	37.4	36.8	35.7	925
36.9	36.4	35.8	34.7	950
35.9	35.4	34.9	33.8	975
35.1	34.6	34.0	33	1000
34.2	33.7	33.2	32.2	1025
33.4	32.9	32.4	31.4	1050
32.6	32.1	31.7	30.7	1075
31.9	31.4	30.9	30	1100
31.1	30.7	30.2	29.3	1125



Contributed by A. Wasbauer,
Engineer, The Ingersoll Milling Machine Company

© American Machinist

American Machinist

Editors: KENNETH H. CONDIT AND FRED H. COLVIN

Vol. 71 New York, August 8, 1929 No. 6

Product Engineering

SO MUCH emphasis has been put on the last two stages in the cycle through which every industrial product must pass before it becomes of use to the community, that there is danger that the vital importance of the first two stages is being overlooked. Production and distribution are occupying the center of the stage, and of late, distribution is threatening to crowd production into the wings.

Both of these phases are unquestionably important. The recognition they have received is probably due to the fact that the great majority of those engaged in industry are either in the production or in the distribution divisions. But, after all, what would there be for all these millions to do if the men who have the original ideas, and who engineer or design them into such shape that they can be made and sold, should cease functioning?

No one has ever attempted a service of ideas, for the obvious reason that workable ideas are the offspring of genius and seldom thrive under the care of foster parents. Besides, such ideas are so valuable that the man who has one keeps it for himself.

But it is different with the second stage—the engineering of the idea to make it producible and salable. A thorough knowledge of the materials that may be used in the product is essential. A wide acquaintance with mechanisms of all kinds is equally necessary. So many new developments in materials, and so many new applications of mechanical movements are being brought out constantly that the individual or group responsible for the design of the product needs all the information that an up-to-date industrial publication can collect.

It is logical to use the word "engineering" in referring to this second stage of the industrial cycle, because "design" implies layouts, tracings, detailing—and those activities are but a part of the picture. Testing and research, the adoption of approved standards, co-operation with the production and marketing divisions, are vital to success, and these lie within the province of the engineer.

This "Product Engineering" number of the *American Machinist* is an effort on the part of the editors to supply the kind of service under discussion to those charged with the engineering of the product. In it is concentrated what would be found normally in four issues of the *American Machinist*. Similar numbers will be published on corresponding Thursdays each month.

*

American Designs Abroad

RECENTLY, in speaking before a group of business paper editors, W. H. Rastall, chief of the Industrial Machinery Division of the Bureau of Foreign and Domestic Commerce, called attention to the great influence that American designs of machinery are having on raising the social and economic life of foreign countries. The point is reminiscent of a report made a few years ago by an American consul to the effect that he found the natives of a large part of Patagonia firmly imbued with the idea that a certain town in Illinois was a place of mechanical geniuses and wonderful men. He traced this to the large number of installations of steel windmill pumps installed in that dry country, which bore the name of the town and the letters U. S. A. Now, in a very much larger manner, and in more generally intelligent fields, American designs of machinery are saving labor and bettering living conditions in all parts of the world.

It was pointed out by Mr. Rastall that the present annual consumption of industrial machinery, which in the United States is about $14 per inhabitant, is less than half that amount in most European countries, and as low as five cents per inhabitant in China. This consumption, however, is rapidly increasing, and without question American designs of labor-saving machinery are becoming models for the world. The machine designer may justly take pride in a work that not only does the immediate job for which the design is intended, but also exerts a continuous influence on the economic progress of the world. Exports of American industrial machinery have increased tremendously in spite of the fact that prices have often been higher, and buying terms less flattering, than those for competing European machines. It is largely to the credit of the designer that this record of progress can be charged.

NEW MATERIALS AND PARTS

And Engineering Equipment

"Peerless" Model 30 Blue-Printing Machine

SPEED of production, quality prints, and low operating cost are claimed for the "Peerless" Model 30 blue-printing equipment announced by the C. F. Pease Company, 813 North Franklin St., Chicago, Ill. The Model 30 will produce blue-prints, negative prints, and blue-line and brown-line prints at a speed of 12 ft. per minute.

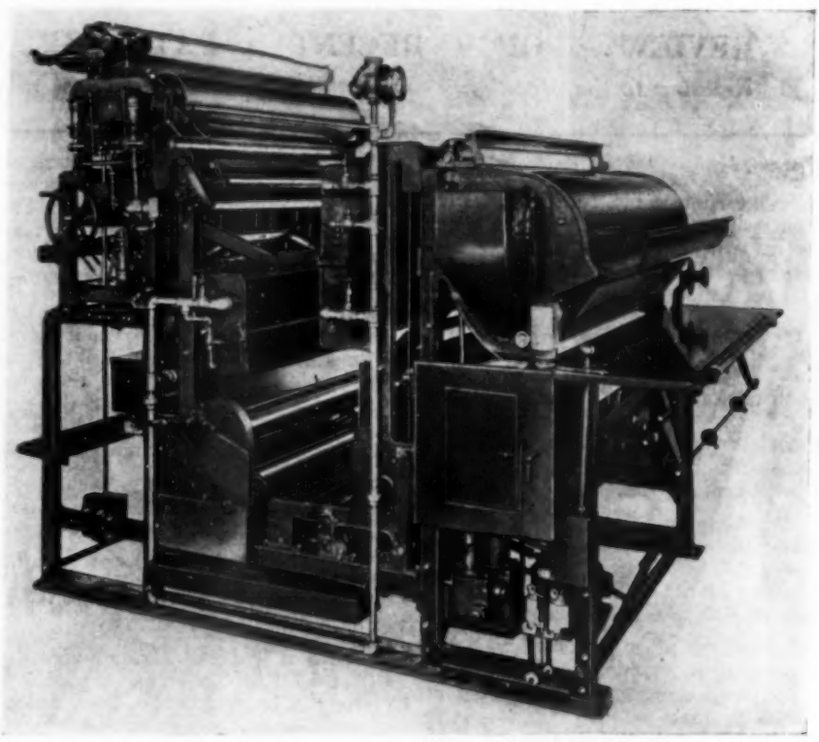
Following the usual practice, tracings are laid face up on a continuous roll of paper feeding at the front of the machine, and are carried upward around a semi-circular, uniformly-curved segment of plate glass, and past a bank of arc lamps individually mounted in horizontal alignment in front of the glass. After exposure, tracings are returned automatically to the tray at the front of the machine near the operator's position, while the prints on the continuous roll of paper are carried through the machine and the subsequent operations of washing, potashing, and drying take place in succession. The paper is then rolled automatically in loose cylinder form at the rear of the machine for convenient cutting and trimming.

The Model 30 is direct gear-driven throughout, has a speed range of from 4 in. to 12 ft. per min. and is powered with a variable-speed ¼-hp. motor, direct-connected to a fully-inclosed, gear-reduction unit running in oil. At the left-hand side of the machine and mounted in the feed table is a four-point auto-type gear shift providing two forward speeds, high and low, also neutral and reverse. The reverse gear permits the operator to withdraw tracings or run back the leader roll whenever desired, without inconvenience. At the right of the machine and mounted above the feed table is another speed control in the form of a hand-operated dial connected by sprocket chain to a rheostat located beneath the feeding table. This additional regulator permits changing the printing speed to the proper rate to conform with the character of tracings that are being printed at the time.

After exposure, as the prints are carried over the top roll of the printing machine, they pass down to a water wash consisting of spray jets directing water over the front and back surfaces of the paper. After washing, the prints pass over in contact with a special 4-in. rubber-covered roll set in a shallow pan at the bottom of the machine. This roll revolves in the direction the paper is traveling and coats the surface of the prints with a uniform coating of potash solution. Negative solution is applied by this roll in the same manner and the interchange of solutions is a simple matter of feed-tank adjustment without danger of dilution. After the developing process with either potash or negative solution, the prints are again washed, as previously described, by another arrangement of powerful spray sets.

The dryer of the Model 30 consists of two chromium-plated copper drums and an auxiliary air-drying unit. These units are in graduated heat arrangement, and, because of the direct roll contact with the paper, prints are dried smooth and free from wrinkles. When especially thin paper is used, a special, felt-roller, ironing attachment is used. This device is attached to the rear roll of the machine and is adjustable so that it can be either raised or lowered into operating position as required.

While the machine has a maximum production of 12 lin. ft. per min. and is particularly adapted to long-run, high-speed production, single prints can be handled also. Model 30 printer can be operated separately from the washing and drying machine by means of a clutch adjustment and can be purchased separately if desired. The Model 30 is made in two sizes, 42 and 54 in. widths, for either 110- or 220-volt d.c. or



"Peerless" Model 30 Blue-Printing Equipment that will produce blue-prints, negative prints, and blue-line and brown-line prints in continuous operation

220-volt a.c. circuits. The 42-in. machine is equipped with six lamps and the 54-in. machine is equipped with seven lamps. These lamps are of the special Type P inclosed arc style and consume either 6½ amp. on d.c. or 7½ amp. on a.c. when adjusted for effective printing speed.

"Hastelloy" Acid-Resistant Alloys

Three acid-resistant alloys, known as Hastelloy "A", "C", and "D" have been placed on the market by the Haynes Stellite Company, Kokomo, Indiana. Hastelloy "A" is designed primarily for resistance to hydrochloric acid, but is also resistant to sulphuric and a number of other acids, but not to nitric acid. It is an alloy of high strength and good ductility and makes excellent castings, which can be forged or rolled into sheet, and which are readily machineable.

Hastelloy "C" is a modified form of the above alloy and is resistant to oxidizing agents such as nitric acid, wet chlorine, and acid solutions of ferric chloride, cupric chloride and other salts of similar nature. The resistance to hydrochloric acid is maintained and the resistance to sulphuric acid slightly enhanced, but it is not possible to work the alloy. It is used in the cast form, and is machineable.

Hastelloy "D" is another casting alloy of somewhat different type and gives resistance to sulphuric acid and to hydrchloric acid, but is not resistant to nitric acid. This alloy is machineable only with difficulty, unless tungsten-carbide tools are used. It can be ground readily. This material is strong and tough.

"Elverite" Chilled Iron

A superior chilled iron has been developed by the Fuller Lehigh Company, Fullerton, Pa., and is being marketed under the name of "Elverite." It is claimed to be an evolution of the "all charcoal" chilling pig irons, and will give a hard chill to the required depth to suit the needs of the casting, while retaining a soft gray-iron core. It thus gives the wear-resisting qualities combined with toughness that are required for such castings as those employed in crushing and pulverizing equipment.

REVIEW · OF · RECENT · PATENTS

Relating to the Machinery and Metal Products Industries

Materials

To the American Steel Foundries has been assigned patent 1,721,555 on a steel for car wheels composed of high manganese pearlitic steel containing 0.50 to 2.00 per cent of chromium.

A copper-manganese-magnesium alloy and a method of making it by interfusing with magnesium a relatively small amount of cupro-manganese having copper and manganese present in about a seven to three ratio, are covered by patent 1,721,768, assigned to The Dow Chemical Company.

The Aluminum Solder Corporation of America has acquired, by assignment, patent 1,721,814 for a solder consisting of about 4⅓ per cent aluminum, 66⅔ per cent of zinc and 29 per cent of tin.

A method of manufacturing hollow connecting rods which involves forming a rod with flanges that afterward are joined to make a tube connecting the bearings at each end of the rod is the subject of patent 1,720,106, assigned to the Willys-Overland Company.

The Bakelite Corporation is assignee of patent 1,720,895, covering a phenolic resin and the process of making it. This non-reactive, fusible resin is the reaction product of a fusible phenol-methylene resin, a basic condensing agent, and furfural.

A gear-molding process which utilizes a ring of binder-impregnated material for forming the periphery of the wheel and a moldable substance for the gear body is the subject of patent 1,719,290, granted to Ernest G. Danielson, of San Francisco, California.

Patent 1,719,970, granted to Hilliary Eldridge, of Oakland, Calif., covers a method of manufacturing calcium carbide and pig iron by subjecting a mixture of calcium carbonate and iron oxide to the action of an electric arc.

The S & T Metal Co. is assignee of patent 1,717,469, covering a method of making a bearing metal from a lead-sodium alloy.

To J. Birchard Green, of Chicago, Ill., has been allowed patent 1,720,039, for a ferrous welding rod with a sulphur content which in the surface portion is less than 0.025 per cent and in the center portion is more than 0.025 per cent.

A method of forming a cylindrical sleeve from a perforated disk is the subject of patent 1,717,419, assigned to the General Motors Corporation.

To the Allegheny Steel Co. has been assigned patent 1,717,468, relating to a method of electroplating ferrous articles with a cobalt-chromium alloy.

A patent, 1,715,105 issued to Edward Slade, of New York, N. Y., covers a clutch lining formed of a fabric having the weft strands of twisted asbestos fiber and wire. The fabric is then impregnated, the blank folded into laminations and stitched, and the whole subjected to heat-treatment and pressure.

A lubricant patented, 1,709,311, by Charles B. De Hart, of Chicago, Ill., is made by mixing mineral lubricating oil with jefferisite and aluminum stearate and heating.

Parts and Mechanisms

Frank P. Miller of Meadville, Pa., has been granted patent 1,716,455 on a rotary cutter having a number of blades not arranged on opposite diameters.

The Kearney & Trecker Corporation has patent 1,715,604 on a transmission and control for machine tools involving a movable support and a clutch-controlled mechanism for the support. The mechanism includes shifter and timer members independently movable.

A lubricant retainer and dust guard for universal joints is the subject of patent 1,717,481, assigned to the Universal Products Co., Inc. It relates to a casing covering a ball-head shaft, a tubular retainer, and means co-operating therewith to prevent escape of lubricant.

A rotary cutter patented, 1,714,700, and assigned to the Western Electric Co., has the cutting teeth set in lateral slots in two cylindrical members and held in place by means of a disk between the two members.

Six patents, 1,713,800-1-2-3-4-5, were issued to Lucius E. Whiton, of New London, Conn., covering various features in automatic lathe chucks. The chucks are arranged with gears or scroll plates with means for rotating them, and means for operating the jaws.

A universal hook patent, 1,713,835, issued to J. L. Krieg, of South Bend, Ind., covers a hook having a cup-like lubricant chamber which holds a screw with a spherical head.

The Cleveland Planer Co. was assigned patent 1,713,873, on a safety attachment for planers, by which the clutch is moved automatically to neutral position to discontinue the movement of the knee at a desired position.

NEW · MATERIALS · AND · PARTS

A speed-controlled hydraulic motor combining a fluid-driven rotor, casing, two independent nozzles with separate supply lines, one of which has a magnetic valve, and other parts, is covered by patent 1,718,935, assigned to the Ex-Cell-O Tool & Manufacturing Company.

To Eugene M. Scoville, of Cincinnati, Ohio, has been granted patent 1,718,985 on a grease-charging apparatus having a detachable magazine, a pressure cylinder and means for withdrawing grease from the reservoir and discharging it.

Two patents, Nos. 1,719,134-5, assigned to the Rotary Machine & Engineering Co., cover two different designs of pumps having eccentric rotors with vanes passing through said rotors.

The Cincinnati Milling Machine Co. is assignee of patent 1,719,693, covering a variable-displacement pump which has a pair of cylinders, two eccentric-operated pistons, and an eccentric arranged to shift the valve mechanism.

Patent 1,720,137, assigned to the Pullman Co., relates to a belt-cleaning device having a scraper roller with its axis of rotation disposed at an angle to the belt.

Patent 1,720,316, allowed to Michael J. Boyle, of Chicago, Ill., covers a poppet valve having a hollow stem closed by the head, the hole containing a non-solid heat-carrying material.

An apparatus for forming tubing from cup-shaped billets by the use of a plurality of reducing dies, and means for forcing a mandrel with the billet thereon through the dies, has been assigned to the Wellman Seaver Rolling Mill Co., Ltd., of London, England.

A device for electrodeposition of metals on the inside of hollow cathode articles in such a way that the gases released do not interfere with the deposition of metal is covered by patent 1,720,354, assigned to the Chromium Plating Corporation of America.

Patent 1,720,422, assigned to the International Motor Co., relates to a shaft coupling incorporating a gear and means for close axial adjustment of the gear.

Vincent J. O'Brien, of Denver, Colo., has secured patent 1,720,431 on a self-aligning wrist-pin bushing with arc-shaped external surfaces.

The International Motor Co. has been assigned patent 1,720,475, on an oil filter so arranged that if the oil pressure rises above a predetermined point, the oil is short-circuited without passing through the filter.

A loading device for grinding machines is the subject of patent 1,720,620 assigned to The Lees-Bradner Co. It comprises, among other parts, a work holder and means for positioning the piece in relation to the tool.

Thomas S. Burke, of Brooklyn, N. Y., has been granted patent 1,720,662 relating to means for producing an electric weld and using a thermionic valve for regulating current flow.

Another electric welding device using a generator with drooping characteristic, a reactance and a resistance, is the subject of patent 1,720,664, assigned to the Wilson Welder & Metals Co., Incorporated.

Patent 1,720,422, assigned to the Burgess-Norton Manufacturing Co., relates to a ball bearing with a novel arrangement of race, cup, cage, and dust ring.

To the Kearney & Trecker Corporation has been assigned patent 1,720,710, covering an adjustable overarm attachment for machine tools, having a transmission gear train to the tool spindle, an extensible coupling and means for maintaining alignment.

The Western Electric Co. has been assigned patent 1,720,759, covering means for supplying the main chamber of an extrusion machine from a plurality of adjacent cylinders.

A brake drum comprising a ferruginous foundation having a coating of a metal of lower corrodibility cemented thereto, is covered by patent 1,720,815, assigned to the Bendix Brake Company.

A second patent, 1,720,853, assigned to the same company, covers a similar drum of ferrous metal having an exterior surface of greater thermal conductivity than the foundation metal.

Henry Bruce Cole, of Bennington, Vt., has been granted patent 1,720,820 on a tool holder in which the tool is clamped by a screw-actuated wedge.

Patent 1,720,852, granted to Edgar B. Nichols, of Moorestown, N. J., relates to a drive chain having angularly disposed connecting strips between pin loops lying in offset planes.

An indexing mechanism, having a ratchet and a crank with a connecting rod pivoted thereto and adapted for alignment of its axis with that of the ratchet, is the subject of patent 1,720,887, assigned to the Gear Grinding Machine Company.

The Una Welding & Bonding Co. is assignee of patent 1,721,296, for an arc-welder electrode holder with a heat and electric insulating shield made in polygonal shape to prevent the holder from rolling when laid down.

Patent 1,721,322, assigned to the Spicer Manufacturing Corporation, relates to a universal joint with spaced recesses in a ring, bearing blocks therein, and a separate cover for each block designed to compensate for variations in depth of recess and length of block.

To the Danly Machine Specialties Co. has been assigned patent 1,721,475 on a hardened, wear-resisting, work-rest for centerless grinders, made from a cast alloy of iron, carbon, silicon, manganese, phosphorous and chromium.

A driven plate for friction clutches, comprising a hub, a pair of friction disks and a compressible cushion between said disks, is covered by patent 1,721,504, assigned to the Borg & Beck Company.

Ralph Kroehle, of Warren, Ohio, has been granted patent 1,721,515, on a commutator comprising bars embedded in a body of metal molded thereon and insulated from the bars.

Patent 1,721,524, granted to Charles E. Moore of San Francisco, Calif., relates to a feed-screw limit gage for lathes, with means whereby the screw may be rotated a fixed number of times.

Means for moving a machine tool support are covered by patent 1,721,668, assigned to the Kearney & Trecker Corporation. It relates to a combination of movable supports, a screw, and a nut with angularly disposed threaded sides.

To the Buckeye Iron & Brass Works has been assigned patent 1,721,678 for a chuck having means to adjust an arm and a rotatable head carried by the arm, without stopping the chuck.

Patent 1,721,729, assigned to the Davenport Machine Tool Co., deals with a tool carrier for a pair of tools, and a mechanism for moving the tools into engagement with the work.

The Cincinnati Bickford Tool Co. is assignee of patent 1,721,740 for a resiliant, spirally-wound shaft guard having overlapping convolutions extensible into a spiral helix.

A self-opening die-head with chasers and a pair of concentric operating sleeves, is the subject of patent 1,721,855, assigned to the Geometric Tool Company.

Harold D. Davis and Charles L. Fowler, of Athens, Tenn., have secured a patent (No. 1,721,988) on a lathe center with a fixed tubular portion, and a spindle, one end of which is supported by a taper roller bearing.

Patent 1,714,711, issued to Jacob G. Elkin, of New York, N. Y., covers a nut lock which consists of a split washer having teeth on the inner face and setting in a recess in the lower part of the nut.

Patent 1,717,385, granted to Karl Jung, Berlin, Germany, deals with a control device especially for grinders, and comprises a sliding carriage with hydraulic operating means.

The General Motors Corporation is assignee of patent 1,717,612, which relates to a trimming die having a fixed

base, reciprocable head, a plurality of cam rods acting on the die, and other co-operating parts.

Child Harold Wills, of Marysville, Mich., has been granted patent 1,717,750, covering a piston of non-ferrous metal electroplated with iron.

Patent 1,717,833, assigned to The Bullard Machine Tool Co., relates to a clutch having a plurality of triangular plate springs and means for free connection of the spring to a driving element.

A connecting-rod structure is covered by patent 1,717,810, assigned to the Worthington Pump & Machinery Corporation. The structure involves a wrist pin box adapted to take up wear.

To the E. W. Bliss Co. has been assigned patent 1,717,814, covering a lubricating system for gearing comprising opposed nozzles to direct oil between gears and means for supplying oil under pressure.

A ball seat member, having a case-hardened bearing surface with soft core and back, is the subject of patent 1,718,229, assigned to Thompson Products, Incorporated.

The Bethlehem Steel Co. is assignee of patent 1,718,240, relating to a device for feeding and holding bolts in a threading machine, that incorporates a slide, movable transversely to the chute and inwardly and outwardly with respect to the threading die.

Hugh M. Rockwell, of Bristol, Conn., has been granted patent 1,718,381, covering a bearing having tubular rollers between race members, rings concentric with the races, rods passing through rollers and rings, and rows of balls between sleeves on the rollers.

Patent 1,718,435, assigned to the Marquette Tool & Manufacturing Co., relates to a hydraulic cushion for metal presses, embodying automatic means for eliminating the shock ordinarily caused by sudden resistance to the liquid in the system.

To the C. R. Carver Co. has been assigned patent 1,718,549, relating to a hand and finger guard for presses, that includes hinged crossing links, arranged to swing in timed relation with reciprocating parts of the press.

An oiling system for a planer is covered by patent 1,718,726, assigned to the Cincinnati Planer Co. The system includes a reservoir on the cross-rail saddle and wick-feed to various bearing surfaces.

The Martin-Rockwell Corporation is assignee of patent 1,718,848, on a ball bearing having a snap ring rim arranged to permit insertion of the balls and thereafter to act as a means for retaining the balls in the bearing.

To the Chisholm-Moore Hoist Corporation is assigned patent 1,720,240, relating to a swiveling hoist structure.

A tubular roller for gravity carriers is the subject of patent 1,720,255, assigned to the Mathews Gravity Carrier Co. A tubular roller with anti-friction bearings and a U-shaped support are important parts.

Charles M. Saeger, of Washington, D. C., has been allowed patent 1,721,092 on a metal-spraying device using a high-frequency induction furnace inside of a casing and means for feeding metal and spraying molten metal.

TRADE PUBLICATIONS

CAST IRON. The International Nickel Co., Inc., 67 Wall St., New York, N. Y., has published Bulletins 201-A and 207 on "An Introduction to Nickel Cast Iron", and "Properties and Applications of Nickel and Nickel-Chromium Cast Iron", respectively. The first gives a brief discussion of the position of cast iron in the engineering field, the trend toward improvements in physical and mechanical properties, and the use of alloys in this connection. The second gives examples of the economic value of the material.

CHAIN DRIVES. The Diamond Chain & Manufacturing Co., Indianapolis, Ind., has published a catalog entitled "Reducing the Cost of Power Transmission," which cites the advantages of "Diamond" chain for reducing the cost of the power transmission. Many different types of installations are illustrated.

COUPLINGS, FLEXIBLE. The Brown Engineering Co., 123 N. First St., Reading, Pa., has published a bulletin entitled "Kanti-Lever Flexible Couplings" giving the constructional features, cross-sectional views, dimensions and prices, installation views, and engineering data. The bulletin contains eleven 11x8½-in. pages.

GENERAL ELECTRIC PUBLICATIONS. The General Electric Co., Schenectady, N. Y., has issued a series of publications as follows: No. 416D, superseding 415A, on the Type CR-7051 automatic starting compensators; No. 571C, superseding 571B, on arc-welding accessories; No. 724B superseding 724A, on totally-inclosed, fan-cooled, squirrel-cage motors, "900" Series; No. 752A, superseding 752, on Type BD d.c. motors; No. 876C, superseding 876B, on the type WD-400-A arc welder; No. 1009A, superseding 1009, on type WD-300-A arc welder; No. 1134 on single-phase directional ground relays.

MAYARI PIG IRON. The Bethlehem Steel Co., Inc., Bethlehem, Pa., has published booklets Nos. 26 and 54 on Mayari pig iron and silvery Mayari pig iron, respectively. The uses of the material for castings of a high test nature, the physical properties, and the chemical content are listed.

UNIVERSAL JOINTS. The Borgeson Manufacturing Co., Torrington, Conn., has published a folder showing the component parts of its universal joints, and giving the specifications for the various sizes.

WESTINGHOUSE PUBLICATIONS. The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., has published two bulletins as follows: No. 1661-D describing Classes 13-125 and 13-225 magnetic starters for use with wound-rotor induction motors, and No. 1842 entitled "Power at the Touch of a Button," describing Linestarters and Linestart motors and their applications.

BEARING BRONZES. The U. S. Department of Commerce, Bureau of Standards, has published research paper No. 68 entitled "Bearing Bronzes With and Without Zinc," which is based on a study of the wearing properties, hardness, structure, notch toughness, and resistance to deformation at temperatures between 70 and 600 deg. F. on the bronzes in the copper corner of the copper-tin-lead system. These bronzes are classified according to the character of the service for which they are best adapted.

CRANKSHAFT DISTORTION. The Ohio State University, Columbus, Ohio, has published Bulletin No. 43 of an engineering series on "The Angular Distortion of Crankshafts," mainly in connection with torsional vibration. The booklet contains twenty 9x6-in. pages. It may be obtained for 25 cents.

ENGINEERING FOUNDATION REPORT —1928. The Engineering Foundation, Engineering Societies Building, New York, N. Y., has published the fourteenth annual report for 1928, which contains data of interest to the metal-working industries. Reports on research on fatigue of metals, wire rope, strength of gear teeth, lubrication, and cutting fluids are of direct interest.

PIPES NIPPLES, WROUGHT-IRON. The U. S. Department of Commerce, Bureau of Standards, has published Commercial Standard CS6-29 giving the dimensions for standard, extra-strong, and double-extra strong wrought-iron pipe, and stock sizes and lengths of standard and extra-heavy black pipe nipples and standard weight galvanized pipe nipples. The bulletin may be obtained from the U. S. Government Printing Office, Washington, for 10 cents.

NEWS
OF THE WEEK

Machine Builders Adopt Standard Color

Machine-tool gray for finishing is approved by the national association

BY A vote of 118 companies in favor, and only five companies opposed, the members of the National Machine Tool Builders' Association have just adopted a color, to be known as the "standard machine-tool gray," for the painting of all machine tools manufactured in future by these companies. This vote of 123 firms represents 85 per cent of the 138 firms belonging to the association.

Members of the association have been furnished with plaques showing the exact color adopted. Since colors change gradually with age and exposure to light, however, a wet sample of paint has also been mailed to each member as an exact guide for the new standard color and gloss. All paint manufacturers will be supplied with a wet sample promptly upon application to the office of the association at 1415 Enquirer Building, Cincinnati. Members will therefore be enabled to obtain the color in either paint or lacquer from their regular sources of supply, and not be dependent upon special vendors.

At the approaching machine-tool exhibit to be held in Cleveland, Sept. 30 to Oct. 4, it is planned to have all exhibitors display machines painted in the new standard color. Exhibitors who are not members of the association will be supplied at once with a wet sample upon request to the association headquarters in Cincinnati.

Dean Kimball Becomes McGraw-Hill Director

Prof. Dexter S. Kimball, dean of the College of Engineering of Cornell University, has been elected a member of the board of directors of the McGraw-Hill Publishing Co., publisher of *American Machinist*. Dean Kimball has long been a leader in the field of engineering education and an active contributor to the scientific and engineering press. He became a member of the Cornell faculty in 1898 as assistant professor of machine design in Sibley College. He resigned in 1901, but returned to the Sibley College staff in 1904, becoming acting president of Sibley from July to October, 1918. In 1921, he became dean of the College of Engineering. He is a member of the A.S.M.E., and the Society for Promotion of Engineering Education.

* * *

Graf Zeppelin Brings Aerial Freight and Mail

Making the westward trip in 93 hours, the Graf Zeppelin completed on Aug. 4 its second trip to the United States, bettering its previous record by 16 hours in spite of adverse winds and weather, demonstrating the mechanical reliability of this type of craft as a long-distance freight and passenger carrier. It carried 20 passengers, 15 bags of mail, and a cargo of freight merchandise, in addition to its crew of 41. Cargo was mainly sample articles consigned to various American cities. Some of the goods was displayed for sale in New York on the following morning to demonstrate the merchandising possibilities. The distance between the coasts of Europe and America was spanned in 67½ hours, an average speed of 55 nautical miles an hour being maintained by the ship. The Graf will return to Friedrichshafen on Aug. 7, after receiving 1,000,000 cu.ft. of special fuel gas and 500,000cu.ft. of hydrogen.

The Graf Zeppelin is the one hundred seventeenth rigid-type dirigible built at the Zeppelin factory at Friedrichshafen, and is similar to the U. S. "Los Angeles," although thicker and more blunt in proportion to its length. It is 778 ft. long overall, and has a maximum diameter of 100 ft., its maximum height being 110 ft. The total weight is 121 tons and the gross lift is 107 tons, the pay load being 15 tons for a 6,000-mile flight. The power plant is five specially-developed, Maybach-Zeppelin, 12-cylinder, water-cooled, V-type, engines, each developing 550 hp., and running at 1,600 r.p.m. The engines each weigh 2,450 pounds.

* * *

Edison Picks Future Engineer-Genius

Following a custom that was much used in ancient times, sometimes with success but most usually with failure, Thomas A. Edison, on Aug. 2, chose a protege to follow him in engineering as the old-time artists and philosophers sought to guide chosen boys into their footsteps. Wilbur B. Huston, the 16-year-old son of an Olympia, Wash., bishop, was the boy selected by the judges from a group of 49 picked youths. Fifty-four questions were given the contestants, more than half of which were on subjects apart from engineering, in order to test the general intelligence of the youths.

The boy chosen as the future engineer-genius will be given a technical education with all expenses paid in a college of his own choice. Four other boys, whose answers to the examination question rated high, will be given their college tuition. The chairman of the judges was Dr. S. W. Stratton, president of the Massachusetts Institute of Technology. The other members of the examining board were: Henry Ford, Charles A. Lindbergh, George Eastman and Dr. Lewis Perry.

Interest in the experiment to choose and train the future engineering genius was widespread. An organization was formed to keep the 49 boys in touch with each other by letter to report progress, and it was planned to have the contestants meet in ten years to note the success of the experiment after a decade has passed.

* * *

A.S.S.T. Announces Papers for Congress

PAPERS to be presented during the annual convention of the American Society for Steel Treating as its part in the National Metals Congress to be held in Cleveland the entire week of September 9, were recently announced by W. B. Coleman, chairman of the meetings and papers committee of the society.

Some of the papers announced by Mr. Coleman are: "Locomotive Forging," "The Distribution of Hardness Produced by Cold Working," "Production of Electric Steel for Castings," "Methods of Tests for Determining Machinability of Metals in General, With Results," "Radiograph as a Tool in the Metal Industry," "Hot Aqueous Solutions for the Quenching of Steel," "Dendritic Steel," "Brittle Range in Chrome-Nickel Iron," "Development of High-Test Cast Irons," "Melting Practice for Three Types of Electric Steel," "Overheating of Steel for Forging," "Dilation of Steel During Quenching," "Non-Destructive Testing," "Conditions Necessary for Blistering of Metal During Processing," "Some Notes on the Behavior of Carbon Tool Steel in Quenching," "Inherent Hardenability Characteristics of Tool Steel" and "A Study of the Critical Ranges in Pure Iron-Carbon Alloys."

BUSINESS BAROMETER

Has the nation reached a period where the price of money has no effect on business? Many maintain that it has

By THEODORE H. PRICE
Editor, Commerce and Finance, New York

IN A FAMOUS decision, Justice Holmes of the United States Supreme Court defined speculation as "an attempt to adjust one's affairs to the probable." The machinery of modern business, including particularly that of the stock and commodity exchanges, has been devised in an effort to facilitate the adjustment to which Justice Holmes referred in the definition quoted.

The operations that are conducted on these exchanges usually reflect with promptitude the probabilities expected, and there are three or four influences whose effect upon prices has hitherto been regarded as inescapable. One of them is high-priced credit. Because it indicates a scarcity of capital, it has always been assumed that its effect would be to restrict business. But this assumption has not been warranted by the experience of the last twelve months, during which period call money has averaged fully seven per cent, and has at times commanded much higher rates.

The question is: "Have we reached a period when the price of money has no effect upon business or the price of securities and commodities?" Many maintain that we have, and if they are right, our philosophy of economics and finance will have to be rewritten. But there are some who persist in believing that there is still a definite relation between the cost of credit and the value of other things.

These reactionaries thought that they found some justification for their conservatism in the action of last week's stock market. During the earlier part of the week it was comparatively dull, and prices slipped away when the call money market advanced. But on Wednesday and Thursday, the bulls made a fresh attempt to revive speculation, and their efforts met with some success. It is plain, however, that enthusiasm is chilled, and that the market would yield readily to any influence which would cause a change in public sentiment.

The world's wheat crop is estimated at 3,180,000,000 bushels against 3,816,000,000 a year ago. This shortage of 16 per cent, while really an economic disaster to the world, taken in its entirety, is bullishly construed in the United States. Because it means that we will get more money for our exportable surplus, the result has been the maintenance of the advance in wheat, and the action of the Farm Relief Board in planning to form a grain marketing corporation, which is virtually a consolidation of the co-operative associations of the grain states, has had a stimulating effect upon the price of all cereals.

The proposed corporation is to be capitalized at $20,000,000, and it is variously estimated that it will represent from 600,000 to 2,000,000 farmers.

The Farm Relief Board has not yet taken any action with regard to cotton. The market for that staple has been acting as if it anticipated that a helping hand would be held out to it in moments of depression, and futures have been remarkably steady when the strike in Lancashire and the optimistic crop reports are considered. The strike in Lancashire involves about 1,800 manufacturing establishments and 500,000 operatives. To England, it is a disaster of the first magnitude, but its effect has been to strengthen the price of cotton goods in other countries, and the improvement in the demand for yarns and cloths may perhaps be responsible for the strength of the raw material. In so far as the American dry goods market is concerned the only effect has been an increased demand for our exportable fabrics, but this has been sufficient to tone up the whole list, and a more cheerful feeling persists. It is generally estimated that the crop outlook is up to normal, and it is expected that the Government Report to be issued on August 8 will show a condition at least equal to the 10-year average of 67.3 per cent.

The rubber markets are waiting to see how great the curtailment of consumption from the spring peak will be, and whether it will be offset by a decline in shipments from the East. Meanwhile they are marking time.

Distributive trade throughout the United States has been remarkably good. Car loadings show a substantial increase over last year. The mail order houses also report sensational gains. The lull in the steel trade has been followed by a speedy revival. A steady demand for copper keeps the price at 18 cents, and the mid-summer outlook in both trade and industry seems to be about as cheerful as could be desired.

In Europe the political situation has settled down into a condition of summer placidity. Hypothetical questions are being discussed, but no issues of real importance are likely to be decided before the autumn. The threat of war between Russia and China now seems to have been unwarranted.

If it were not that call money continues to command 9 or 10 per cent, the outlook would be almost flawless. The high cost of credit is the only reason for believing that the cost of other things may be too high.

Copyrighted
Theodore H. Price Publishing Corporation
16 Exchange Place, New York

From this page the reader will get a quick picture of current business and industry. The boxed material below is a summary of the letters from regional correspondents of the American Machinist, published in full on the opposite page.

AUGUST is expected generally to compare favorably with July in the machinery and machine-tool industry. While some sections report a lull, others announce an increase, all sections uniting in anticipation of better fall business.

DETROIT reports a fairly high level for this time of the year, with no change apparent in the near future. The Southern district continues slow, with some signs of improvement during the coming month. Chicago reports a seasonal decline, with good inquiries and delivery improving. In New York, a definite falling off in small equipment demand has occurred, but an unusually strong demand continues for large standard production machinery. September is expected to bring improvement.

MILWAUKEE is optimistic, with machine-tool demand back to the peak. A slight August lull is anticipated, however, as also one in Indianapolis, where business is continuing at a good level. New England machine-tool industries are moderately active, with August bringing better conditions. In Cincinnati, the demand is good, considering the season, and both orders and inquiries are better. In Canada, the advance of the steel industry is the outstanding feature, with employment setting new high records, and August looking even better. In all sections, railway buying is poor. Purchases are mainly those required for replacement, company executives' vacations limiting large or unusual orders.

THE INDUSTRIAL REVIEW

Weekly progress of the machinery and machine tool business

THE following reports, gathered from the various machinery and machine tool centers of the country, indicate the trend of business in these industries and what may be expected from the future:

CHICAGO

Conditions in the machine-tool market show evidence of the expected seasonal decline which attends the annual vacation period. This year, exceptional trade activities extending into July have somewhat deferred the recession, but there now seems to be no question as to its having arrived. There still is reported by some district representatives and distributors a good level of business, but most machinery concerns admit that since the middle of July there has been a measurable falling off. Demand on the part of railroads, with one exception, still is limited largely to single tools. The exception referred to is the Northern Pacific, which is inquiring for several units for its shops, shortly to be required. The International Harvester Co., for some weeks past reported to be preparing a list which will cover a variety of machine shop equipment, apparently has such a list near completion, this being indicated by tentative inquiries it has sent out within the last week for figures on a number of units, several of which are for heavy duty. Demand on the part of automotive manufacturers is less active than it has been for the last several weeks. Deliveries, while still far from meeting requirements, are said to be slowly improving. Business in used tools is reported to be quiet.

NEW YORK

The machine tool situation shows trends, even more marked than a week ago, toward a definite falling off in inquiries and orders for small equipment, but an unusually strong demand for the larger types of standard production machines. Dealers in smaller machines attribute the drop to vacation influences, absence of the men who do the buying, rather than to any recession of business. However, plants using larger machine tools appear to be so rushed with orders that they are compelled to obtain new equipment at the earliest possible time. Even machines that are not commonly sold, but that appear on stock lists because they have been on hand for some time, or have been put through as extras in regular production lots, although not on order, are now being rapidly bought up.

Several dealers and representatives in the standard lines of machine tools report July business equal to June, and, in a case or two, one of the best months in the last two years, even in the light of recent high records. Equipment comprising the fast-moving class includes milling machines, planers, radial drills, lathes of all types, and power bending brakes. The industries reported most active in the market are the automotive, electrical, aircraft, textile machinery builders, pressed metal plants, machine tool builders, jobbing or contract shops, and, to a more limited extent, railroad shops. General Electric and Western Electric continue to make purchases to take care of their increasing production requirements. Expansion seems to account for most of the demand.

Prices show no change, but the general impression is that any movement will be upward. Deliveries are uniformly worse. Milling machines, boring mills, and some other types of equpment are now quoted for January and February delivery. Sales are outstripping production, due to the lack of machine capacity and skilled mechanics in the machine tool manufacturers' plants. The difficulty of getting work out during the hot weather is an additional factor slowing up operations and deliveries. In some cases plants have been unable to live up to promised deliveries, and are a month or two behind. Most orders received today must be checked for delivery date by telephone or telegraph to the factory, before the customer can be made a promise.

Used machinery suffered a little falling off in demand during the latter part of July, and the month was not so good as June. August, however, shows a substantial improvement. Prices are holding up and high-production machinery is hard to secure.

The outlook for August is very good in the standard lines of larger equipment, but not so favorable for the smaller machines. In September, however, dealers anticipate that the latter will again be in good demand. The fall in fact, may bring in the biggest three months total business that the New York district has ever obtained.

DETROIT

While nothing of unusual importance is taking place in the industries here the machinery and machine-tool trade has maintained a fairly high level for this time of year. The market for the first part of August and the last few days of July has been fairly regular with nothing to indicate an industrial development. Orders for replacement equipment have been coming in steadily, and from present indications, the month gives promise of being at least as prosperous as July.

A few of the large automobile manufacturers are making inquiries on expensive machinery. Some important changes in design are being planned, but thus far these plans have not resulted in orders.

Most of the automobile and accessory manufacturers are waiting until fall before making extensions and additions. The usual summer inventory and vacation period will probably extend well into the latter part of August.

Business in general is extremely dull in the entire Detroit area and employment is lower than it has been for many months.

NEW ENGLAND

New England's machine tool industry continued moderately active and in the past week closed a good amount of business. Small orders predominated among the transactions, mainly for small tools and machines. No orders for large lists were noted, and those placed showed a widespread industrial representation. Inquiries were fairly numerous and indicative of better fall business.

Manufacturers believe that August will see an upward trend in orders and that the lightest month of the year has passed. July results, however, presented the usual difference of opinion. Some manufacturers experienced a better month than June. As a whole, the month totals were below those of June. July, when compared with the heavy buying months of early spring, shows sharp declines, but as compared with corresponding months business was well above the average July.

Indications in this district point to increased buying of machine tools through the Fall months. The automobile and aeronautical industries are expected to play prominent parts in this anticipated forward buying. The Pratt & Whitney Aircraft Co. has started work on the new East Hartford plant, where another factory is to be erected for the Chance Vought Corporation at an estimated cost of $1,000,000, both of which will involve the purchase of a large volume of machine tools.

Some companies have sent out inquiries for 1929 requirements. The used-tool demand is slow but the demand exceeds the supply. Two Michigan automobile manufacturers are expected to take the machinery from the Locomobile plant at Bridgeport, where alterations are being made.

MILWAUKEE

After a very slight recession, machine-tool demand is back near the peak again. Whatever gap has been left by a slowing up in the large passenger-automobile industry has been more than filled by the metal-working shops generally. Inquiries from the automobile manufacturers indicate liberal purchases from that source in the fall. Motor truck and tractor manufacturers are as busy as they have been at any time during the year. Manufacturers of agricultural implements are anticipating and getting ready for a heavy fall trade. Improved conditions are also noted in the woodworking plants which, it is believed, will result in a revival of demand from them them after a prolonged period of slackness.

Almost all of the business which is crowding the dealers and machine-tool producers has been coming very recently from the smaller plants in every conceivable line of business. Garages in particular have been taking standard equipment in great quantities. Tool and die shops are also strong in the market and state that their own business is better now that it has been in the early part of the month or in June.

Slight, if any, change has taken place in the delivery situation, but it is believed that an easier tendency is under way and that August will permit manufacturers of milling machines and other items on which considerable delay in delivery dates has been prevalent to advance deliveries at least a few weeks. This expectation is based on the probability that there will be a lull during August and on the expansion which has been rushed along in the plants of almost all of those who supply machine shop needs.

CINCINNATI

Considering the season, the demand has been very good in the past week with machine-tool manufacturers of the Cincinnati district, according to statements made by heads of leading concerns. The great majority report that sales remained at about the same level as in the previous week, but in a few cases it was reported that there was a slight lull.

Selling agents report that business held up well, with about the same volume of orders as were booked in the previous week. The fact that representatives and also prospective customers are taking their

summer vacations, it is explained, is having a retarding effect, but, nevertheless, business is at a better-than-fair level.

The sustaining feature of the week's market was the demand for single tools and replacements, but among the orders booked were several that called for two or three tools. The great majority of the buyers were general machinists and miscellaneous users, located in all sections of the country, whose requirements were well diversified. Purchases by railroads and concerns in the automotive industry and its allied trades were confined to single items.

What is regarded as an encouraging feature is the fact that a good volume of inquiries were received in the week—much larger than is usual at this season. While these were confined largely to single items, they formed a very substantial aggregate.

INDIANAPOLIS

Machine-tool and machinery business continues at a good level in this area, according to manufacturers and dealers. There has been nothing that could be called a summer slump. Business has continued its activity and the fall promises to be exceptionally bright. The one dark spot in the business right now is the demand from the local automobile factories, which is not as brisk as the trade would like, but is somewhat better than it was at this time last year. This applies only to actual automobile factories manufacturing pleasure cars. The demand from truck factories and body plants for machine tools and special machinery is good, as is that from the factories making automobile accessories.

Business has been good all summer with the garages, most of the demand being for grinding equipment, small lathes, hoists, and similar equipment. Demand from the contractors, both building and road, for special equipment has been good during the past month, but has been held back during most of the season by bad weather. The last two weeks have seen a lot of new business booked with these firms. Weather, of course, has helped this business.

Another good source of business during the last month has been the gravel plants. Special equipment has been installed in many of them, both replacements and new installations. The electric and gas utilities of the state have been ready purchasers of a wide variety of equipment. The railroads are confining their purchases to actual needs, which seem to be about the same as last year. Interurban demand is off largely due to financial conditions prevalent in these utilities.

SOUTHERN DISTRICT

Southern machinery and machine tool business continues rather slow, distributors advise, though the inquiry is showing signs of improvement and these are expected to develop somewhat better volume during the present month. Reports reaching the dealers from their sales representatives out in the territory are optimistic over the late summer and fall outlook, when trade is expected to show a decided turn for the better and a good increase over the corresponding period last year. Crop conditions are excellent all over the South this year, and exceptionally good prices are prevailing.

Some of the pine mills are curtailing or shutting down for a temporary period owing to low prices, and using this time to install needed equipment, though woodworking machinery as a whole is quiet, without much promise of any early betterment. Some good sales of both new and used equipment are still being made in the textile field, but this trade also is quieter than it has been. However, railroads continue fairly active in the market and have recently placed some rather sizeable orders for heavy equipment for shop use. Demand is slower than last summer for contractors' machinery and equipment as building is much less active, but is reported about on a par with normalcy at this period. A few sales of road-building equipment are also reported, but this line, too, is showing a tendency to decline. Smaller shops and garages are placing orders as before, either for used or rebuilt equipment with the business as a whole slow.

CANADA

The rapid advance being made by the steel industry is an outstanding feature of the metal-working situation in Canada. Steel mills and a large number of other industrial concerns associated with the iron and steel industry established new production records for the first half of this year. Shipments were upwards of 15 per cent greater than those of the corresponding period last year and sales and specifications advanced 20 to 25 per cent over those of the best half-year since 1920.

A pronounced seasonal decline in automobile production was reflected in the output figures for June when only 21,492 cars were made in Canada. The output in May was 31,559 cars. Employment in the Dominion has reached a new high rate of activity for all time. Every month this year has shown larger figures than last year.

* * *

Russians Large Buyers Of American Equipment

The Amtorg Trading Corporation, American trading representatives of Soviet Russia, placed orders in the United States during the month of July to a total of $20,100,000, it was announced recently by Saul G. Bron, chairman of the company. This amount is the largest amount of business consummated by the company in any single month since its organization five years ago. Purchases by the Amtorg for the entire Soviet fiscal year 1925-26 amounted to $13,157,000 and for last year to $33,100,000, while for the ten months ending July 31, 1929, the orders placed aggregated $51,000,000. The total Soviet-American trade amounted to $115,000,000 last year, as compared with $48,000,000 in 1913. Of the orders placed in July, agricultural equipment, largely tractors, made up 60 per cent, while the bulk of the remainder consisted of industrial and electrical machinery and automotive products. Machinery and machine tools are important items in Soviet purchases in the United States during the month of July.

* * *

Summer Camp Used By G. E. to Train Executives

Five more employees of the Fort Wayne, Ind., works of the General Electric Co. left recently for Associated Island, Lake Ontario, to attend the third of a series of camps conducted by the company for representatives from all over the country. Those leaving were: Walter Goll, manager of the Fort Wayne works; J. H. Evans, assistant to the manager; E. J. Graham, superintendent of the fractional-horsepower motor division; E. E. Miles, assistant production manager; J. L. Bireley, engineer of the meter department, and P. O. Noble, assistant engineer of the fractional-horsepower motor engineering department.

Designer Wins $100 For Riveting Method

HARRY SUSSMAN, designing draftsman in the Brooklyn Navy Yard, is the recipient of a $100 prize and a note of congratulation from the Secretary of the Navy as a result of the acceptance of his method of riveting ships which eliminates the necesity of reinforcing plates at the bulkheads of the watertight compartments of battle cruisers. Mr. Sussman's method was used on the treaty cruiser Pensacola, and resulted in a saving of $5,000 in construction.

Business Items

The Brooks Steam Motors, Ltd., is being reorganized by G. T. Clarkson, Toronto, receiver appointed by the courts more than two years ago to arbitrate the long-standing and complicated dispute between the Brooks interests and the numerous shareholders in the enterprise. A Dominion charter has been granted for the incorporation of Dominion Steam Motors, Ltd. The new company will reopen the Brooks plant at Stratford, Ont.

The Eclipse Machine Co., Ltd., Walkerville, Ont., has begun a large expansion program. This includes a new factory addition, 300 x 100 ft. and a new office building. The estimated cost of the factory addition is $100,000, exclusive of equipment, while the office will probably cost about $75,000.

The Michigan Steel Tube Products Co. has begun an expansion program involving more than $300,000 in its plant in Hamtramck. The additions will give the plant a capacity of 5,500,000 ft. of electrically-welded steel tubing each month.

The Wolverine Carburetor Co. of Michigan has just taken over the factory building formerly occupied by the J. C. Manufacturing Co., Jackson. Associated in the concern are T. G. Atkins, the inventor, F. W. Urch, and Warren W. Mitchell.

Robbins & Myers, Inc., Springfield, Ohio, will reopen its Xenia, Ohio, plant in the near future for the manufacture of fans and motors. The plant has been idle since 1921.

The Champion Spark Plug Co. of Canada, Windsor, Ont., has announced plans for the enlargement of the factory at a cost of about $200,000. It is stated that the enlarged plant will allow a production of 5,000,000 spark plugs a year.

Steel & Tubes, Inc., has recently opened a new welded-steel tubing plant at Ferndale (Detroit), Mich. The unit will be 537 x 211 ft. and will produce 3,000,000 ft. of steel tubing per month.

The Carbon and Alloy Steels, Ltd., plant at Welland, Ont., now owned by R. S. Hart, manager of the National Steel Car Corporation, will be rehabilitated. It is understood that plans are

to get the plant into operation within the next few weeks. Title to the plant has been registered under the name of National Steels, Ltd., but no announcement has been made as to what products the plant will produce.

The Landis Machine Co., Waynesboro, Pa., has opened a branch office in Cleveland, Ohio, at 504 Marshall Bldg., which will be in charge of J. T. Banchoff, district manager.

The Clark Transmission Co., Berrien Springs, Mich., is planning a plant expansion. Ground will be broken in a few days for a new plant that will double the output and the number of employees.

The Standard Devices, Co., Youngstown, Ohio, plans to build a plant in the near future, according to an announcement by George H. Jones, general manager.

The J. A. Fay & Egan Co., Cincinnati, has appointed the Jenison Machinery Co., 58 Fremont St., San Francisco, as agent for Northern California.

The Hurricane Motor Co., Inc., 2103 Walker St., Houston, Tex., is planning a plant for the construction of airplane motors.

The Barker Machine & Foundry Co. is establishing a plant at Souderton, Pennsylvania.

Personals

WALTER M. SUTTON, formerly in charge of the St. Louis office of the W. A. Jones Foundry Co., Chicago, has been appointed manager of the Pittsburgh office. WARREN C. WEBB, former Chicago sales manager for the company, has been appointed Pacific Coast sales manager, with offices at 443 E. Third St., Los Angeles.

F. D. WALLACE, factory manager of the J. D. Adams Co., Indianapolis, was the principal speaker at the last meeting of the manufacturers group of the Chamber of Commerce at Crawfordsville, Ind. He told of the increasing problems that are confronting manufacturers and the imperative need for increased efficiency in production.

ROBERT K. PLUMMER, formerly in charge of the Milwaukee, Wis., office of Gears and Forgings, Inc., has been made assistant sales manager of the company, with offices in Cleveland. George W. Davis, formerly of the Chicago office of the company, succeeds Mr. Plummer as manager of the Milwaukee branch office.

HAROLD S. FALK, vice-president and works manager of the Falk Corporation, Milwaukee, Wis., has been appointed chairman of the Committee on Industrial Education of the National Metal Trades Association. Mr. Falk is also a member of the Committee on Education and Training for the Industries of the A.S.M.E., and has been chairman of the apprenticeship committee of the Milwaukee branch of the National Metal Trades Association for the past 7 years.

JEAN ROCHE, senior engineer at Wilbur Wright Field, Dayton, Ohio, will become president of the Aeronautical Corporation of America, Cincinnati, on Aug. 15. Mr. Roche is the inventor of the flivver plane which the company expects to manufacture soon.

JOHN ECKERLE, president of Aluminum Industries, Inc., Cincinnati, has sailed for Europe to make an inspection tour of the company's European distributors and to visit car manufacturing plants.

WILLIAM FORSTRUM, who has been chief engineer for the Wisconsin Steel Co., Chicago, for the past 9 years, has retired because of ill health. He will make his home in Tucson, Arizona.

KENITH M. LANE has been appointed chief engineer of the aeronautical section of the U. S. Department of Commerce, succeeding LAWRENCE KERBER, who recently resigned to become president of the Spartan Aircraft Company.

R. G. CHAMBERLAIN, former district manager of the Hurley Machine Co., has been appointed factory vice-president of the company with offices in Seattle, Washington.

THOMAS L. THOMAS, formerly vice-president of the McKay Machine Co., Youngstown, Ohio, will become affiliated with the Wean Engineering Co., there, in an executive capacity.

F. C. FAUSTMANN, formerly vice-president of the Royal Typewriter Co., Hartford, Conn., has been elected president of the company to succeed G. E. Smith, who resigned.

DARIUS E. PECK, assistant manager of the law department of the General Electric Co., has been elected vice-president and general counsel of the company.

MATTHEW C. BRUSH, president of the American International Corporation, has been elected a director of the Foster Wheeler Corporation.

W. E. WORTH, Room 518, 216 Pine St., San Francisco, has been appointed Pacific Coast representative of the American Gas Furnace Company.

JAMES F. SEEGER, now employed with the Page-Hersey Tubes, Ltd., Welland, Ont., has been appointed water works engineer at the Welland filtration plant, Welland, Ontario.

FRANK G. MASINI, Kearny, N. J., has incorporated the Acme Tool & Machine Company.

Obituaries

WILLIAM F. HARMON, assistant to the treasurer of the United Shoe Machinery Co., died recently at his home in Belmont, Mass. Mr. Harmon was 67 years old and was a native of Cincinnati, Ohio. He was secretary and treasurer of the Ross-Moyer Manufacturing Co., and had been western representative of the United Shoe Machinery Company.

ARMISTEAD K. BAYLOR, General Electric commercial engineer, died on Aug. 1 at Ipswich, Mass., where he was summering. Mr. Baylor was also vice-president of the Edison Electric Appliance Company.

NATHANIEL P. HILL, vice-president and general manager of the Durable Manufacturing Co., New York, died at Montclair, N. J., on July 28. He was 59 years of age.

ALLAN HOFFMAN, executive vice-president of American Cirrus Engines, Inc., died at his home in Englewood, N. J. on July 28 at the age of 56 years.

JOHN FELTES, vice-president of the Standard Electric Tool Co., Cincinnati, died from pneumonia on July 24.

Forthcoming Meetings

NATIONAL METAL CONGRESS. To be held in Cleveland September 9 to 13. Simultaneous meetings of the American Welding Society, the Institute of Metals Division, American Institute of Mining & Metallurgical Engineers, Iron & Steel Division, American Society of Mechanical Engineers, the Iron & Steel Division, A.I.M.E., and the American Society for Steel Treating. W. H. Eisenman, secretary, 7016 Euclid Ave., Cleveland, Ohio.

NATIONAL METAL EXPOSITION. Eleventh annual, held under the auspices of the American Society for Steel Treating, Cleveland Public Auditorium, Cleveland, Sept. 9-14. W. H. Eisenman, secretary, 7016 Euclid Ave., Cleveland.

AMERICAN RAILWAY TOOL FOREMEN. Annual convention at Hotel Sherman, Chicago, September 11 to 13. C. C. Ziegler, secretary-treasurer, 611 West Washington Blvd., Chicago.

MACHINE TOOL BUILDERS EXPOSITION. Under the auspices of the National Machine Tool Builders Association, Sept. 30 to Oct. 4, in the Public Auditorium, Cleveland, Ohio. Ernest F. DuBrul, general manager, 1415 Enquirer Bldg., 617 Vine St., Cincinnati.

SOCIETY OF INDUSTRIAL ENGINEERS. Sixteenth national convention at Hotel Statler, Cleveland, October 23 to 25. Requests for programs should be sent to S.I.E. national office, 205 West Wacker Drive, Chicago.

AMERICAN GEAR MANUFACTURERS' ASSOCIATION. Semi-annual fall meeting at the Benjamin Franklin Hotel, Philadelphia, October 24 to 26. T. W. Owen, secretary, 3608 Euclid Ave., Cleveland.

THE WEEKLY PRICE GUIDE . . .

Rise and Fall of the Market

SEVERAL important price advances occurred during the last week, accompanied by no major declines. The materials affected were, babbitt metal, solder, lead, tin, scrap zinc and linseed oil. Steel mill output rate is 96 per cent of capacity, compared with 95 per cent in mid-July. This gain reflects demand for railway material and heavy hot-rolled products. Prices are firm on all items except sheets and wire products. Recession in these is due to smaller volume of automotive requirements.

(All Prices as of Aug. 2, 1929)

IRON AND STEEL

PIG IRON—Per gross ton, f.o.b:

CINCINNATI	
No. 2 Southern (silicon 1.75@2.25)	$18.44
Northern Basic	20.89
Southern Ohio No. 2	21.19
NEW YORK—Tidewater Delivery	
Southern No. 2 (silicon 1.75@2.25)	20.75
BIRMINGHAM	
No. 2 Foundry (silicon 1.75@2.25)	14.00@14.50
PHILADELPHIA	
Eastern Pa., No. 2x (silicon 2.25@2.76)	21.76
Virginia No. 2	24.79
Basic	20.76
CHICAGO	
No. 2 Foundry local (silicon 1.75@2.25)	20 00
No. 2 Foundry, Southern (silicon 1.75@2.25)	20.76
PITTSBURGH, including freight charge ($1.76) from Valley:	
No. 2 Foundry	19 76
Basic	19 26
Bessemer	21 26

IRON MACHINERY CASTINGS—Cost in cents per lb. of 100 flywheels, 6-in. face x 24-in. dia., hub not cored, good quality gray iron, weight 275 lb:

Detroit	4.50
Cleveland	5.00
Cincinnati	4.50
New York	5.25
Chicago	4.50@4.75

SHEETS—Quotations are in cents per pound in various cities from warehouse; also the mill base in large lots:

Blue Annealed*	Pittsburgh Mill Base	Chicago	Cleveland	New York
No. 10	2.20@2.35	3.35	3.30	3.90†
No. 12	2.25@2.40	3.45	3.35	3.95†
No. 14	2.35@2.50	3.55	3.45	4.00†
No. 16	2.45@2.60	3.65	3.55	4.10†
Black				
Nos. 18 to 20	2.65@2.75	3.85	3.70	3.80
No. 22	2.80@2.90	4.00	3.85	3.95
No. 24	2.85@2.95	4.05	3.90	4.00
No. 26	2.95@3.05	4.15	4.00	4.10
No. 28	3.10@3.20	4.75	4.15	4.25
Galvanized				
No. 10	2.80@2.90	4.20	4.05	4.05
Nos. 12 to 14	2.90@3.00	4.30	4.15	4.15
No. 16	3.00@3.10	4.40	4.25	4.25
No. 18	3.15@3.25	4.55	4.40	4.40
No. 20	3.30@3.40	4.70	4.60	4.55
No. 22	3.35@3.45	4.75	4.65	4.60
No. 24	3.60@3.70	4.90	4.75	4.75
No. 26	3.75@3.85	5.15	5.00	5.00
No. 28	4.00@4.10	5.40	5.25	5.25

*Light plates. †Up to 3,999 lb.

WELDED STEEL PIPE—Warehouse discounts are as follows

	New York		Cleveland		Chicago	
	Black	Galv.	Black	Galv.	Black	Galv.
1 to 3 in., butt welded	50%	36%	55½%	43½%	54%	41%
2½ to 6 in., lap welded	45%	32%	53½%	40½%	51%	38%

WROUGHT-STEEL PIPE LIST

Size, Inches	List Price per Foot	—Diameter in Inches— External	Internal	Thickness Inches
1	$0.17	1.315	1.049	.133
1¼	.23	1.66	1.38	.14
1½	.27½	1.9	1.61	.145
2	.37	2.375	2.067	.154
2½	.58½	2.875	2.469	.203
3	.76½	3.5	3.068	.216
3½	.92	4.0	3.548	.226
4	1.09	4.5	4.026	.237
4½	1.27	5.0	4.506	.247
5	1.48	5.563	5.047	.258
6	1.92	6.625	6.065	.28

SEAMLESS STEEL TUBING—Following net prices are for seamless mechanical tubing, cold drawn, round, .10 to .30 carbon, at New York warehouse in lots of less than 100 ft. or 100 lb:

— Thickness — B.w.g. and Decimal Fractions		Outside Diameter in Inches — Price per Foot ½	⅝	¾	⅞	1	1⅛	1¼
.035″	20	$0.15	$0.16	$0.17	$0.18	$0.19	$0.21	$0.23
.049″	18	.17	.18	.19	.20	.21	.23	.25
.065″	16	.19	.20	.21	.22	.23	.25	.27
.083″	14	.20	.22	.23	.24	.25	.27	.29
.095″	13	.21	.23	.25	.26	.27	.29	.31
.109″	12	.22	.24	.26	.27	.28	.30	.32
.120″ or .125″	11	.23	.25	.27	.28	.29	.31	.33
.134″	10	.24	.26	.28	.29	.30	.32	.34

MISCELLANEOUS—Warehouse base prices in cents per lb:

	New York	Cleveland	Chicago
Spring steel, light*	4.50	4.65	4.65
Spring steel, heavier	4.00	4.00	4.00
Coppered Bessemer rods	6.05	6.00	6.20
Hoop steel	4.25†	4.00	4.15
Cold rolled strip steel	6.25	6.00	6.10
Floor plates	5.10†	5.30	5.00
Cold drawn, round or hexagon‡	3.60	3.65	3.60
Cold drawn, flat or square‡	4.10	4.15	4.10
Structural shapes	3.30†	3.00	3.10
Soft steel bars	3.25†	3.00	3.00
Soft steel bar shapes	3.25†	3.00	3.00
Soft steel bands	3.75†	3.65	3.65
Tank plates	3.30†	3.00	3.10
Bar iron (2.75 at mill)	3.25	3.00	3.00
Drill rod (from list)	60%	55%	50%

*Flat, $\frac{3}{16}$-in. thick. †Up to 3,999 lb., ordered and released for shipment at one time. ‡Cold finished steel, shafting and screw stock.

Electric welding wire at New York warehouse— $\frac{3}{32}$, 8.35c. per lb; $\frac{1}{8}$, 7.85c. per lb.; $\frac{5}{32}$ to $\frac{1}{2}$, 7.35c. per lb.

METALS

Warehouse Prices in Cents Per Pound for Small Lots:

Copper, electrolytic, New York			19.25
Tin, Straits, pigs, New York			49.50
Lead, pigs, E. St. Louis	6.60	New York	8.00
Zinc, slabs, E. St. Louis	6.80	New York	8.25

	New York	Cleveland	Chicago
Antimony, slabs	11.00	12.25	14.25
Copper sheets, base	27.75	27.75	27.75
Copper wire, mill, base	19.87½	19.87½	19.87½
Copper, drawn, round, base	26.25	26.25	26.25
Copper tubing, base	29.25	29.25	29.25
Brass sheets, high, base	23.25	23.25	23.25
Brass tubing, high, base	28.25	28.25	28.25
Brass rods, high, base	21.25	21.25	21.25
Brass wire, high, base	23.75	23.75	23.75

SHOP MATERIALS AND SUPPLIES

METALS—Continued

	New York	Cleveland	Chicago
Aluminum ingots, 99%.....	25.00*	24.30	24.30
Zinc sheets (casks).....	10.50@11.00	11.70	10.11
Solder (½ and ½).....	33.75	32.75	31@34
Babbitt metal, delivered in case lots, New York, cents per lb:			
Genuine, highest grade.....			65.00
Commercial genuine, intermediate grade.....			48.00
Anti-friction metal, general service.....			31.50
No. 4 babbitt.....			12.00

*Delivered.

NICKEL AND MONEL METAL—Price in cents per lb., base, f.o.b. Huntington, W. Va:

	Nickel	Monel Metal
Sheets, full finished.....	52.00	42.00
Sheets, cold rolled.....	60.00	50.00
Strip, cold rolled.....	55.00	45.00
Rods, hot rolled.....	45.00	35.00
Rods, cold rolled.....	53.00	40.00†
Tubing.....	75.00*	90.00
Angles, hot rolled.....	50.00	40.00
Plates.....	52.00	42.00

*Seamless. †Cold drawn.

OLD METALS—Dealers' purchasing prices in cents per pound, f.o.b. cars, depending on quantity offered for sale:

	New York	Cleveland	Chicago
Crucible copper.....	15.25 @15.50	13.50	13.00 @14.00
Copper, heavy, and wire..	14.00 @15.25	13.00	12.00 @13.00
Copper, light, and bottoms	12.50 @13.25	12.50	11.00 @12.00
Heavy lead.....	5.12½@ 5.37½	6.25	4.75 @ 5.25
Tea lead.....	3.50 @ 4.00	4.25	3.75 @ 4.25
Brass, heavy, yellow.....	8.50 @ 9.00	8.00	8.00 @ 8.50
Brass, heavy, red.....		12.50	11.75 @12.25
Brass, light.....	7.00 @ 7.50	7.50	7.00 @ 7.50
No. 1 yellow rod turnings.	9.50 @10.00	9.00	9.00 @ 9.50
Zinc.....	3.25 @ 3.75	3.25	3.00 @ 3.25

TIN PLATES—Charcoal—Bright—Per box:

	New York	Cleveland	Chicago
"AAA" Grade:			
IC, 14x20.....	$12.10	$11.95	$11.50
"A" Grade:			
IC, 14x20.....	9.70	9.90	9.50
Coke Plates—Primes—Per box:			
100-lb., 14x20.....	6.45	6.10	7.00
Terne Plates—8-lb. Coating—Small lots—Per box:			
IC, 14x20.....	7.75@8.00	7.00	7.50

MISCELLANEOUS

	New York	Cleveland	Chicago
Cotton waste, white, per lb.*	$0.10@0.13½	$0.16	$0.15
Cotton waste, colored, per lb.*	.09@ .13	.12	.12
Wiping cloths, washed white, per lb.†.....	.16	38.00 per M	.16
Sal soda, per lb.....	.02½	.02	.02
Roll sulphur, per lb.....	.027	.03½	.04
Linseed oil, raw, in 1 to 4 bbl. lots, per lb.....	.136	.11	.137
Cutting oil, about 25% lard, in 5 gal. cans, per gal.....	.75	.60	.65
Machine oil, medium-bodied (55 gal. steel bbl.) per gal..	.33	.36	.35
Belting — Present discounts from list in fair quantities (½ doz. rolls) for leather or rubber:			
Leather—List price, 24c. per lin. ft., per inch of width, for single ply:			
Medium grade.....	30–10%	30–10%	35%
Med. grade, heavy wgt...	30– 5%	30– 5%	30%‡
Rubber transmission, 6-in., 6 ply, $1.83 per lin.ft:			
First grade.....	50%	50–10%	50%
Second grade.....	60%	60– 5%	50–10%

*All waste in bale lots. †100-lb. bales.

Comparative Warehouse Prices

New York	Unit	Current Price	Four Weeks Ago	One Year Ago
Soft steel bars.....	per lb..	$0.0325	$0.0325	$0.0325
Cold drawn shafting...	per lb..	.036	.035	.034
Brass rods.....	per lb..	.2125	.2125	.17
Solder (½ and ½).....	per lb..	.3375	.325	.315
Cotton waste, white...	per lb..	.10@.13½	.10@.13½	.10@.13½
Disks, aluminum oxide mineral, cloth, No. 1, 6-in. dia.....	per 100.	3.60	3.60	3.10
Lard cutting oil.....	per gal.	.75	.75	.65
Machine oil.....	per gal.	.33	.33	.30
Belting, leather, medium.....	off list..	30–10%	30–10%	31½%
Machine bolts, up to 1x30 in., full kegs...	off list..	50-10%*	50–10%*	50%*

*List prices as of April 1, 1927.

MISCELLANEOUS—Continued

	New York	Cleveland	Chicago
Abrasive materials — Standard grade, in sheets 9x11 in., No. 1, per ream of 480 sheets:			
Flint paper.....	$4.86	$4.29	$4.29
Emery cloth.....	22.93	20.97	20.97
Disks, aluminum oxide mineral, 6 in. dia., No. 1, per 100:			
Paper.....	2.08	2.04	2.04
Cloth.....	3.60	3.59	3.59
Fire clay, per 100 lb. bag.....	1.00	.75	.75
Coke, prompt furnace, per net ton...	Connellsville,		2.75@2.85
Coke, prompt foundry, per net ton...	Connellsville,		3.75@4.85
White lead, dry or in oil...	100 lb. kegs....	New York,	13.75
Red lead, dry.....	100 lb. kegs....	New York,	13.75
Red lead, in oil.....	100 lb. kegs....	New York,	15.25

SHOP SUPPLIES

Discounts from new list dated Apr. 1, 1927, applying on immediate deliveries from warehouse stocks in New York and vicinity:

Machine bolts:	
Up to ¾-in. x 6-in., full kegs, list less.....	60%
Larger, up to 1 x 30-in., full kegs, list less.....	50–10%
Less than full kegs or case lots, add to list.....	10%
Fitting-up bolts: list less.....	45%
Lag screws:	
Up to ½-in. x 6-in., list less.....	60%
Larger, list less.....	50–10%
Less than full keg or case lots, add to list.....	10%
Rivets:	
Structural, round head, full kegs, net.....	$4.50
Structural, round head, broken kegs, net.....	6.00
Tank, $\frac{7}{16}$-in. dia. and smaller, list less.....	60%
Nuts:	
Hot pressed, square or hexagonal, blank or tapped:	
Full kegs up to 1-in., incl., list less.....	60%
Larger, up to 3-in., list less.....	40–10%
Less than keg or case lots, add to list.....	10%
Washers:	
Wrought, full kegs, per 100 lb., list less.....	$4.00
Wrought, broken kegs, per 100 lb., list less.....	2.00
Turnbuckles:	
With stub ends, list less.....	20%
Without stub ends, list less.....	50%
Chain:	
Proof coil, base, per 100 lb., net.....	$7.10
Cast iron welding flux, per lb., net.....	.40
Brazing flux, per lb., net.....	.80

MACHINE REQUIREMENTS AND INDUSTRIAL CONSTRUCTION

Equipment Wanted

Ind., Alexandria—General Insulating Co.—Machinery for manufacture of insulating material, for 3 story and 1 story plant addition. Estimated cost $40,000.

Ind., Anderson—Forse Equipment Co., 14th and Fairview Sts.—machinery and equipment, for manufacturing dry cleaning machinery. Estimated cost $50,000.

Mich., Detroit—Dongan Electric Mfg. Co., 2987-3001 Franklin St.—machine shop equipment for expanding plant, for manufacture of bell ringing, radio and fixed condensers and equipment.

Mich., Detroit — Murray Body Corp., Clay Ave.—assembly system, for auto bodies, for plant on which contract is awarded, Clay Ave.

Mich., Flint—Flint Foundry Co., 702 West Kearsley St.—foundry equipment for proposed iron foundry, West Kearsley St. Estimated cost $100,000.

N. J., Edgewater—Ford Motor Co., Dearborn, Mich., will receive bids about August 8, for assembly line equipment, for proposed assembly plant, here.

Mich., Detroit—McManus Steel & Iron Co., 3290 Wight St.—electric furnace for heat treating steel.

O., Canton—Hercules Motor Corp., 140 Hallowall Pl.—machinery for manufacturing motors. Estimated cost $25,000 for plant, for which contract is awarded $100,000.

O., Columbus — McClure-Nesbitt Motor Co., 1503 East Main St.—1 air compressor; 1 medium sized drill press; 1 grinding machine; 1 small lathe for proposed garage and service station.

R. I., Providence—City, P. Bldgs. Dpt.—manual training machine tools, for proposed Junior High School, Chalkstone St.

Tex., San Antonio—Alamo Aircraft Corp., taking bids equipment for motor repairing and for airplane factory, to be built here. Estimated cost $250,000. A. K. Longren, c/o owners, engr.

Ont., Toronto—Hamilton Bridges Wks., Ltd. Bay St. N., shears, drills, presses, riveters, forges, and electrically driven machinery for structural steel fabricating shop. Estimated cost $250,000.

Opportunities for Future Business

Calif., Los Angeles — Community Securities Corp., awarded contract for a 2 story, 140 x 230 ft. garage and sales building. Estimated cost $195,500.

Calif., Los Angeles—K. C. Gillette, Los Angeles, awarded contract 2 story, 102 x 128 ft. factory for manufacture of high precision machines. Estimated cost $57,350.

Calif., Los Angeles—R. D. King, archt., Van Nuys Bldg., taking bids 1 story 97 x 150 ft. main shop, Central Ave. and 15th St. for Standard Auto Body Wks., 15th and Central Ave.

Calif., Los Angeles—Merchants Parking Arcade, Spring Arcade Bldg., is having preliminary plans prepared for a 12 story garage on 6th St. Estimated cost to exceed $150,000. K. Macdonald, Spring Arcade Bldg., archt.

Calif., San Jose—Anderson Barngrover Co., West Julian St., plans the construction 1 story, 85 x 220 ft. assembly plant, for fruit packing machinery. Pleasant St. Estimated cost $40,000. C. W. McKenzie, Bank of San Jose Bldg., archt.

Colo., Denver—Curtis Flying Service, 29 West 57th St., New York, plans the construction shops, hangar, school, for airport, here. Estimated cost $70,000. C. Russell, 29 West 57th St., New York, engr.

Conn., Beacon Falls—H. D. Bronson Co., awarded contract 2 story, 35 x 100 ft. brass goods manufacturing plant. Estimated cost $45,000.

Conn., East Hartford (br. Hartford)—Pratt & Whitney Aircraft Co., 450 Capital Ave., Hartford, awarded contract 2 story, 400 x 1,500 ft. airplane factory, South Main St. Estimated cost $1,500,000. Noted May 24.

Conn., Groton—Vanadium Metals Co., Post Rd., awarded contract 1 story, 50 x 120 ft. foundry, Boston Post Rd. Estimated cost $40,000.

Conn., Hartford—L. Schoolnik, 44 Hebron St., is having plans prepared for a 1 story, 60 x 130 ft. sales and service station on Farmington Ave. Estimated cost $60,000. Berenson & Moses, 252 Asylum St., Archt.

Conn., Hartford—R. P. Taber, 128 Allyn St., awarded contract for a 1 story, 200 x 250 ft. garage and service station on Albany Ave. Estimated cost $175,000. Noted July 4.

Conn., Norwalk—N. Wessman, 10 Main St., taking bids garage, West Ave. Estimated cost $160,000. Lang & Rosenberg, 110 West 40th St., New York, archts.

Conn., South Norwalk—Nash Engineering Co., Wilson Rd., will build 1 story 30 x 180 ft. plant addition. Estimated cost $40,000.

Conn., Waterbury—Connecticut Light & Power Co., 111 West Main St., awarded contract for filtering service building, Freight St. Estimated cost $100,000.

Conn., Waterbury—Scoville Mfg. Co., 99 Mill St., awarded contract 4 story, 25 x 165 ft. plant, for manufacture brass, bronze, etc., Silver St. Estimated cost $45,000.

Fla., Miami—Curtiss Flying Service, 29 West 57th St., New York, will receive bids on general contract after August 15, Curtiss-Municipal Airports, incl. hangar, shop, etc. C. Russell, 29 West 57th St., New York, engr.

Ind., Brazil—Western Oil Co., awarded contract service station. Estimated cost $46,100.

Ind., Evansville—F. W. Cook, awarded contract shop and garage, 208 South 8th St. Estimated cost $44,200.

Ind., Evansville—Evansville Quality Co., will build machine shop and garage, Water St. Estimated cost $43,000. Thole & Legeman, Evansville, archt.

Ind., Fort Wayne—La Barbarea, 3504 South Calhoun St., plans the construction 1 story, 80 x 160 ft. service garage and salesroom, Taylor St. Estimated cost $42,160.

Ind., Lafayette—Northern Indiana Service Co., awarded contract plant. Estimated cost $45,000. F. P. Riedel, Lafayette, archt.

Ind., Muncie—Glascock Bros., 1515 West 15th St., manufacturers washing machines, baby carriages, etc., awarded contract 3 buildings, 50 x 80 ft. West 15th St. Estimated cost $75,200.

Ky., Louisville—Swartz, Clifford & Scott, St. Matthews, awarded contract garage and service rooms. Estimated cost $40,000. G. H. Rommel Co., 958 Logan St., archt.

Md., Baltimore—Curtiss Airports, Inc., 29 West 57th St., New York, awarded contract airport development, incl. hangars, shops, etc. Estimated cost $3,000,000. Stone & Webster, 120 Bway., New York, engrs. and contractors.

Mass., Boston—City of Boston, School House Dpt., soon lets contract Michael Angelo School, addition, incl. assembly hall and shops.

Mass., Brookline—A. Snyder and M. Rudnick, 18 Tremont St., will build 3 story, 100 x 155 ft. garage and repair shop, Commonwealth Ave., near St. Mary's St. Estimated cost $250,000. Noted July 11.

Mass., Everett—B. Movitz, 431 Bway., will build 1 story, 120 x 135 ft. service and repair garage. Estimated cost $150,000. Private plans.

Mich., Dearborn—Ford Motor Co., Collidge Hy., awarded contract 1 story, 130 x 620 ft. and 120 x 122 ft. addition for airplane plant. Estimated cost $300,000.

Mo., St. Louis—Motor Transportation Co., 1803 Park Ave., will build 1 story, 134 x 150 ft. garage and service station, Spring and Rutger Sts. Estimated cost $40,000.

Mo., St. Louis—Western Automobile Co., Washington Blvd. and Euclid Ave., awarded contract 3 story service and sales building, Washington and Euclid Aves.

N. Y., New York—H. Friedman & Son Realty Co., 343 Lexington Ave., plans the construction of service garage, 609 West 134th St. Estimated cost $175,000. C. B. Meyers, 31 Union Sq., archt.

N. Y., New York—McSim Realty Corp., E. Simberg, pres., is receiving bids on general contract auto laundry and service garage. Estimated cost $40,000. A. J. Simberg, 1133 Bway., archt.

N. Y., New York—United American Metal Corp., L. Muscat, pres., 59 Paige St., plans construction of 2 story, 125 x 125 ft. shop, Scott Ave. and Randolph St. Estimated cost $40,000. G. Erdy, 788 Manhattan Ave., archt.

N. C., Wilmington—Thompson Lumber Co., plans the construction large plant to specialize in hardwoods, on 17 acre site.

O., Cleveland—Automobile Service Corp. of America, 45 Nassau St., New York, plans the construction 1 story, 27 x 256 ft. auto repair shop, etc., 7404 Euclid Ave. Estimated cost $100,000. Shattuck & Loyer, North La Salle St., Chicago, Ill., archts.

O., Cleveland—Curtis Airports Corp., 29 West 57th St., New York, awarded contract airport, incl shops, hangars, etc. Herrick Airport. Estimated cost $2,000,000.

Stone & Webster, 120 Bway., New York, engrs. and contractors.

O., Salem—Mullins Body Co., 1018 Mill St., plans constructing 1 story, 104 x 202 ft. sheet metal factory. Estimated cost $60,000. Private plans.

Pennsylvania—Aluminum Company of America, New Kensington, will build 130 x 482 ft. machine shop; remodeling plant for pattern and material storage, at New Kensington; also constructing tube mill addition, at Arnold. Estimated cost $1,000,000. J. W. Schreiber, Smithfield Bldg., Pittsburgh, engr.

Pa., Ellwood City—Aetna Standard Eng. Co., Home Savings & Loan Bldg., Youngstown, A. W. Paisley, secy., will soon receive bids 1 story, 40 x 45 ft. and 45 x 120 ft. additions. Estimated cost $40,000. Private plans.

Pa., Erie—Erie Bolt & Nut Co., awarded contract 1 story, 50 x 140 ft. machine shop and storage.

Pa., Philadelphia—Atwater Kent Co., Wissahicken and Abbottsford Rfs, plans the construction of 1 story, 500 x 900 ft. radio manufacturing plant. Ballinger Co., 12th and Chestnut Sts., archt.

Pa., Philadelphia—Pennsylvania R.R. Co., T. J. Skillman, ch. engr., Broad St., Station, soon lets contract for the construction of 1 story, balcony, 137 x 325 ft. and 23 x 119 ft. electric car shops, Wayne Junction. Clark & Dillenbock, Reading Terminal, archts.

Pa., Pittsburgh—J. L. Stuart, 518 Oliver Bldg., soon takes bids garage, Melwood and Denver Sts. Estimated cost $160,000.

Tex., San Antonio—Aviation Corp., G. B. Grosvenor, pres., 122 East 42nd St., New York, soon takes bids "University of the Air," incl. repairing shop, hangars, etc. Estimated cost $250,000. K. Francine, c/o owner, New York, archt.

Vt., Barre—Wetmore Morse Granite Co., will build 1 story, 50 x 160 ft. machine shop and blacksmith shop. Estimated cost $52,000. L. F. Caroni & Co., 1056 Chapel St., New Haven, Conn., archt.

Wash., Bellinghan—Puget Sound Power & Light Co., H. B. Sewell, mgr., will receive bids about September 15, 100 x 125 ft. service building, etc. Estimated cost $200,000.

Wis., Milwaukee—Universal Power Shovel Co., 5323 Burnham St., awarded contract 1 story, 100 x 225 ft. machine shop, Burnham St.

Ontario—Canadian Pacific Ry. Co., J. M. R. Fairbairn, ch. engr., Windsor Station, Montreal, Que., plans the construction extension machine shop, Smith's Falls; extending machine shop, North Bay, and 150 tin track scales for Prescott.

Ont., Southampton—Bell Furniture Co., H. Bell., mgr., plans the construction plant addition. Estimated cost $50,000.

Ont., Toronto—Canadian Pacific Pipe Co., Ltd., plans the construction new plant. Estimated cost $100,000.

Que., Hull—Hull Iron Steel Foundries, Ltd., Redenter St., awarded contract foundry.

Jugo-Slavia—Ford Motor Co., Highland Park, Detroit, Mich., plans automobile factory, on Dalmation coast, here.